ENERGY EFFICIENCY DEMONSTRATION SCHEME

A Review

Spare

1 ENERGY EFFICIENCY SERIES
ENERGY EFFICIENCY OFFICE

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Department of Energy

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Notes for guidance and conversion tables

Each section consists of text followed by one or more tables. Each demonstration project in the first table is identified by a number, and this number is repeated for identification purposes in the second table.

Energy units used throughout the text are:
1. The SI unit of the joule and its multiples (see below)
2. The tonne of coal equivalent

A conversion table is given below.

S. I. Multiples

Factor	*Prefix*	*Energy Unit*
10^3	kilo	kJ
10^6	mega	MJ
10^9	giga	GJ
10^{12}	tera	TJ
10^{15}	peta	PJ

Conversion factors for energy units

from \ to	Btu	joule	kWh	therm
Btu	1	1.055×10^3	0.2931×10^{-3}	10×10^{-6}
joule	0.948×10^{-3}	1	0.2778×10^{-6}	9.48×10^{-9}
kWh	3.412×10^3	3.6×10^6	1	34.12×10^{-3}
therm	100×10^3	105.5×10^6	29.31	1

1 tonne of coal equivalent (tce) = approximately 27 GJ (heat supplied basis)

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Introduction

(Dr W M Currie)

The Scheme — How it works

There are a number of obstacles to achieving the substantial economic savings that would result from widespread increases in the efficiency with which energy is used. One such obstacle is a reluctance to invest in what are regarded as 'unproven' techniques and technologies. Extensive studies have shown that there is a large backlog of available but apparently 'unproven' technologies. The 'proving' of these technologies by Demonstration installations could unlock the potential savings if accompanied by a successful publicity programme to make customers aware of the possibilities and give reassurance on achievable performance based on commercial and monitored installations. This problem is being tackled by the Energy Efficiency Office with the Energy Efficiency Demonstration Scheme (ED). The scheme seeks to encourage £800 million per annum savings on fuel bills over about a 10-year period through the stimulation of £3,000 million investment in energy efficiency plant, equipment and buildings. This Report outlines a sector by sector, and project by project, strategy to achieve these objectives, including interim programme targets together with statements on progress made so far. It is being published to give the maximum opportunity for those interested in participating both to influence the future shape of the programme and to become involved in individual projects. It will be necessary to have close harmony with the construction and equipment supply industries if the objectives are to be achieved.

The aim of the Energy Efficiency Demonstration Scheme (ED) is to promote the adoption of new or improved techniques and technologies for the more efficient use of energy. The way it works is that selected innovative projects receive grant support (typically 25%) from the Energy Efficiency Office. In return for the grants, companies must allow the projects to be monitored by an independent consultant appointed by the Energy Efficiency Office. The results are then publicised by the Office to encourage others to follow suit and 'replicate' the project.

The object is to stimulate at least £5 per year of energy saving for each £1 that the Government spends on the Scheme. Each project must therefore be replicated many times and a major part of the resources are devoted to marketing and publicity, in close co-operation with the relevant equipment suppliers. The scheme is a collaborative exercise between the Government, equipment suppliers and energy users to help reduce energy costs by the marketing of new energy efficient technologies.

The scheme is managed on behalf of the Office by the Energy Technology Support Unit (ETSU) at Harwell and the Building Research Energy Conservation Support Unit (BRECSU) at the Building Research Establishment. ETSU deals primarily with industry and non-domestic buildings, while BRECSU covers housing. The Office itself mounts a substantial promotional programme to bring results to the attention of the relevant decision makers.

Progress to mid-1984

The Demonstration strategy has evolved to the point where:

- marketing studies have enabled the production of this plan:
- a substantial number of projects have been established, mainly in the industrial area but also, increasingly, in buildings;
- a publicity programme is underway for projects where results are available.

By the middle of 1984:

- approximately 250 projects have been approved;
- 180 installations are operational;
- 83 monitoring reports have been completed;
- 82 projects have evidence of replication.

The costs of the scheme to date and the resulting initial energy savings are as follows:

Total cost of projects	£61 million
Grant support from Goverment	£12 million
Project and replication energy savings achieved	¾ million tonnes of coal equivalent per year
Long term target saving	5 Mtce per year

The long term target is the national energy saving which will be achieved by early 1990s through replication of successful projects.

There are also shorter term interim targets and the scheme is being monitored against those targets. Any known follow-on installation similar to a demonstration which occurs after a project is established, where for example the demonstration is known to have influenced the follow-on is counted as replication. Actual replication results are shown in Table 1 against the first interim targets set for April 1984 for each of the main market sectors in industry and non-domestic buildings. The programme exceeded its initial target and while it is still very early days to be certain of long term success the marketing and promotion programme is being built up in the light of the encouraging results.

Future development of the programme

Future development of the programme is concerned with two main activities:

— the short term promotion plan to achieve the later replication targets for existing projects;

— a longer term plan to expand the number of projects with the accompanying promotion programme for the full 530 projects outlined in the detailed sector strategies in the later sections of this Report.

Short term promotion plans for existing projects

On the strength of the replication already achieved and the latest market information, further interim targets have been set for December 1985 and June 1988. Table 2 lays out those replication targets for each of the industrial and non-domestic

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Table 1. Targets for April 1984 compared with actual achievements for the different sectors.

SECTOR	APRIL 84 TARGET tce/year	KNOWN REPLICATION	
		NUMBER OF INSTALLATIONS	ESTIMATED ENERGY SAVING (tce/year)
Metals & Engineering	73,000	169	130,000
Ceramics	100,000	23	64,000
Chemicals, Oil, CHP, etc	22,000	48	42,000
Food, Paper, Textiles etc	30,000	168	66,000
Waste as Fuel	33,000	12	41,000
Energy Management Systems	90,000	1,143	130,000
Other Non-Domestic Bldgs.	14,000	687	9,000
Sub-Total	362,000	2,250	482,000
Total (including replication and original project savings)			≃ ¾ Mtce/pa

Table 2: Targets for December 1985, June 1988 and long term (Early 1990s) compared with existing replication.

	Realised by May 1984 (tce/year)	Future Targets (tce/year)		
		Dec 1985[1]	June 1988[1]	Long Term
Metals & Engineering	130,000	320,000	530,000	1,000,000
Ceramics	64,000	100,000	330,000	600,000
Chemicals, Oil, CHP etc	42,000	110,000	350,000	550,000
Food, Paper, Textiles, etc	66,000	110,000	380,000	650,000
Waste as Fuel	41,000	120,000	420,000	800,000
Energy Management Systems	130,000	260,000	460,000	700,000
Other Non-Domestic Bldgs	9,000	70,000	260,000	500,000
Sub-Total	482,000	1,080,000	2,730,000	4,800,000
Total (including replication and original project saving)	¾ Mtce	1½ Mtce	3 Mtce	5 Mtce

[1]To nearest 10,000 tce

buildings sectors. If these interim targets are achievable then a long term target of around 5 Mtce per year saving by the early 1990s is possible including the housing sector which is not set out in the table.

The financial and investment implications of the programme of existing projects are shown in Table 3 assuming an average value for fuel saved by the scheme of £80 per tce (1984 prices) for the mixture of fuels typical of the programme. If the 5 Mtce per year long term target is achieved then £400 million per year of energy will be saved requiring an investment of approximately £1,200 million. An average of £12 million investment will need to be made each month over the next few years.

The promotion programme to help achieve this investment is growing rapidly. Information on each project is prepared at various stages of its life from an initial summary sheet, known as the Project Profile when it is first commenced, a further expanded Project Profile when final results are available together with a detailed performance report from the independent monitoring. An enquiry and mailing system has been established to distribute this information and a promotional programme including Open Days, Seminars and Conferences is expanding rapidly with each event directed towards the particular target audience for the individual product.

Table 3: Energy saving targets expressed in money terms.

	December 1985	June 1988	Early 1990s
Energy Savings (Mtce/year)	1½	3	5
Value of Energy (1984 prices)	£120M	£240M	£400M
Necessary investment or equipment sales	£300M	£700M	£1,200M

The longer term plan

A substantial series of studies together with the experience of the staff involved at ETSU and BRECSU has produced detailed knowledge of the state of the art in the various sectors and of the possibilities for further improvements in energy efficiency. Shopping lists of potential projects which are likely to give a

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high return have therefore been drawn up by sector and technology. Estimates of the energy savings from existing and future projects have been summarised in Table 4. The longer term plan therefore includes not only the promotion of existing projects but also the establishing, monitoring and promotion of a total of about 530 projects covering industry, non-domestic buildings and housing. Successful implementation of the plan would result in a long term energy saving of 10 Mtce per year equal to a little over 3% of current consumption. This would require a total investment of £3,000 million. It these targets can be achieved then the original £5 per year saving for an initial £1 input of Government money would be comfortably exceeded.

Table 4: Overall plan for the Demonstration Scheme.

	No. of projects	Energy saving target (Mtce/yr)
Industry	320	7
Non-domestic bldgs	120	2
Domestic	90	1
TOTAL	530	10

Detailed sector strategies
The remaining sections of the Report give detailed plans for each of the 25 sectors for technologies which are currently seen as of prime importance. Each plan is made up of three components.

First, there is a brief strategy statement which outlines the current energy use, the potential for energy efficiency, the scope for innovation and the role which the Demonstration Scheme might play. It also summarises the current status of the programme. This is followed by a table which summarises the proposed long term programme in broad terms. It lists existing projects, any prospective projects which are under discussion and possible further requirements for additional projects. Any relevant projects which are supported under the European Community Demonstration Scheme are also listed since they will be promoted as part of the UK scheme. It is the aggregation of all this information which is summarised in the outline programme statements given above.

Finally, each plan has a table with the short term replication targets for existing projects. Most of these have been checked through market research. The targets for December 1985 and June 1988 are firm management objectives for the staff involved. The long term targets are indications of the ultimate market penetration which is expected.

It is hoped that by exposing these plans to public view and criticism it will be possible to refine them to ensure that the maximum economic returns are gained by encouraging investment in innovative techniques and technologies which will by then be of proven performance and capable of achieving substantial improvements in energy efficiency.

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Section 1 The steel industry

(Dr P B Taylor)

Energy use

The iron and steel industry is one of the largest industrial consumers of energy in the UK accounting for 18% of the total energy consumed by industry or 6% of the total energy consumed by final users in the country. Current consumption (heat supplied) is around 13 Million tonnes of coal equivalent (Mtce)/year (330 PJ/year) (17.5 Mtce/year on a primary basis)[1], with the largest fuel input being in the form of coal for coking (and, in turn, iron making) which represents approximately 50% of the total energy input. The private sector produces approximately 15% of the finished steel products and consumes 10% of the total primary energy attributable to the industry. The greater energy-intensiveness of the nationalised sector arises from its heavy engagement in coke making and iron making. The specific energy consumption for steel making has fallen from about 36 GJ/tonne in 1956 to 21.3 GJ/tonne in 1981. Energy currently represents approximately 40% of the total production costs of semi-finished steel. This value has increased in recent years mainly as a result of significantly reduced manning levels.

The scope for improved efficiency

The longer term energy conservation potential within the industry is approximately 20%. The opportunities may be categorised on three levels (with percentage energy saving levels in brackets) as follows:

- *Raw material and manufacturing process changes (5%)*
  Major advances have already been achieved here in terms of the complete elimination of open-hearth steel making practice, the exclusive use of high-grade foreign ore and the continuing introduction of continuous casting.
- *Technology improvements (10%)*
  A diverse range of proven technology is already available from overseas and the industry is actively enhancing some of its current plant. The economic case for introducing some foreign plant, such as coke dry cooling, is still not attractive. However, it is from under this heading that many of the projects appropriate for support under the Energy Efficiency Demonstration Scheme (ED) can be expected to emerge.
- *Good housekeeping (5%)*
  Considerable potential exists here which has been examined under the Department of Trade and Industry Industrial Energy Thrift Scheme[2].

One technology which has received widespread adoption in the industry is microprocessor control on reheating furnaces. This usually offers short payback times (typically 5 months to a year) and has not been regarded as requiring any ED support to stimulate replication. Moreover, the potential benefits have been such that companies have not usually wished to seek ED support.

Proposed programme and energy saving targets

The private sector and, in many cases, the nationalised sector are eligible for support under the terms of the ED Scheme. In view of the replication requirements of the ED Scheme all the project proposals have to be relevant to the private sector so as to merit support. This restricts the source of projects to electric arc furnace steel manufacture and finishing operations only.

In addition, the private and nationalised sectors are eligible for support from the EEC Energy Conservation Demonstration and Research and Development Schemes. The British Steel Corporation (BSC) takes advantage of these schemes and has submitted a number of successful proposals. A further source of financial support is the European Coal and Steel Community (ECSC) Fund which contributes to a wide range of projects most of which are not directly energy related. The BSC receives significant support from this source to which it also contributes under a levy arrangement.

Iron making, and steel making by the BOS process, is undertaken in the UK solely by the BSC. As mentioned above, projects in this sub-sector are therefore ineligible for UK support and ED proposals have not been sought. However, the EEC favours projects in this sector and, as will be noted from Table 1.1, a balanced distribution of EEC supported projects exists.

Regarding the ED Scheme, priority is being given to comparatively low-cost plant enhancement projects which in addition to being innovative and cost-effective in energy terms stand a good probability of replication. It is unlikely that expensive energy saving projects, even though very attractive in payback terms, will attract much replication in the present economic climate owing to lack of investment funds. Hence the essential steel making activities where the ED Scheme has an important role are:

- Ladle and tundish preheating for liquid steel transfer;
- Heating (of ingots for primary rolling and forging);
- Reheating (of intermediate products such as bloom, bar and strip);
- Heat Treatment (of finished steel shapes).

The steel castings and drop forging industries still retain a separate identity within the industry and are served by their own Research Associations. It is expected that a comparatively small number of projects eligible for support under the ED Scheme will emerge in these sectors.

The potential energy savings within the industry arising from technological improvements is approximately 1.75 Mtce/year. The contribution which the ED Scheme could make to this, assuming a comprehensive programme of projects and widespread replication, is approximately one third (587,000 tce/year) (see Table 1.1).

1 Energy Audit Series Report No. 16 on Energy Consumption and Conservation in the Iron and Steel Industry was published in 1982.

2 IETS Report No. 40 on Energy use in the Private Steel Industry was published in 1983.

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Table 1.1 The steel industry: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
COKE MAKING	†		(Combustion of disticoke battery waste gases — NSF Ltd)			
IRON MAKING	†		(Installation of a recuperator on blast furnace stoves — Hoogovens)			
	†		(Microprocessor control of blast furnaces — Italsider SpA)			
	†		(Heat recovery from blast furnace stoves — USINOR)			
	†		(Electricity generation from blast furnace gas — Thyssen AG)			
STEEL MAKING	†		(Fume removal from electric arc furnace plant — Teksid SpA)			
	†		(Pre-heating scrap for electric arc furnaces — British Steel Corporation)			
	†		(Pre-heating scrap for electric arc furnaces — Daniels and C Officine)			
	†		(Gas recovery, storage and distribution on an integrated works — USINOR)			
	†		(Utilisation of low calorific value gases — Hoogovens)			
	*	1	Tundish drying — Allied Steel and Wire	4	18	Aug 1984
	*	2	Ladle pre-heating — GKN Brymbo	67	31	Mar 1984
	*	3	Ladle pre-heating — BSC Stainless		15	Dec 1984
				71	64	
STEEL FINISHING — Heating and Reheating	†		(Heat recovery from a steel rolling mill — SDRW)			
	†		(Longitudinal temperature regulation in a strip rolling mill — CEM)			
	*	4	Recuperative burners on a forge furnace — Sheffield Forgemasters Plc	16	46	May 1982
	*		(Regenerative burners on a heavy forge reheating furnace — Sheffield Forgemasters)	(50)	(52)	
	*	5	Planetary mill furnace heat recovery — Ductile Planetary Mill Ltd		18	Mar 1982
	*	6	Recuperative burners on a reheating furnace — Dudley Port	370	22	May 1982
	+	7	Ingot reheating furnace enhancement scheme — GKN Brymbo		182	Apr 1986
	*	8	Heated ENCO panels (mainly for heat treatment) — Barworth Flockton		57	Nov 1985
	o	9	Ingot heat retention	30	60	
	o	10	Hot surface inspection of continuously cast material	40	60	
				456	445	
STEEL FINISHING — Heat Treatment	*		(Regenerative burners on a continuous heat treatment furnace — BSC Stainless)	(50)	(176)	
	†		(Energy recovery in paint curing ovens — British Steel Corporation)			
	†		(Use of fluidised bed furnaces for heat treatment — Fulmer Research)			
	†		(Metal hardening using a fluidised bed — Italtractor)			
	o	11	Controlled atmosphere heat treatment furnace	30	60	
				30	60	
DROP FORGING	*	12	Bar heating fluidised bed furnace — Halladays	16	42	Sept 1984
	o	13	Novel firing of slot furnaces	14	30	
				30	72	
			TOTAL	587	641	

KEY * Existing project
+ Prospective project
o Required project
† EEC project

NB Items and values in brackets are not included in the above totals. They are incorporated in the figures for other technologies elsewhere in the document. EEC demonstrations are excluded.

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Current status of the programme

In terms of completing the programe of projects, good progress has been made with approximately two thirds of the required programme being supported. It should be noted that the current programme is not as ambitious as that which was envisaged at the inception of the ED Scheme but this takes recognition of the significant contraction of the industry over the past four years.

To date the programme includes eight demonstration projects representing a Government commitment of £250,000 and target energy savings of 473,000 tce/year (Table 1.2).

Future plans

Future plans include the identification of new projects which are appropriate for ED support. Key areas for attention are the reduction of energy consumption in electric arc furnace operations, heat recovery from hot solids and controlled atmosphere heat treatment. Other more specific topics will also be included where sufficient replication interest exists within the industry. Promotion of current and forthcoming demonstration projects will be sustained and a detailed evaluation of replication achievements will be undertaken.

Energy conservation potential summary

- Current energy consumption by the industry (primary basis) — 17.5 Mtce/year
- Technological potential for energy savings adopting all measures (e.g. process change, good housekeeping) — 3.5 Mtce/year
- Potential for energy savings arising from innovative measures — 1.75 Mtce/year
- Contribution which might be stimulated by the ED Scheme — 0.59 Mtce/year
- Target energy savings of *currently* supported projects assuming widespread replication in the longer term — 0.49 Mtce/year

(All energy units are on a primary basis)

Table 1.2 The steel industry: Replication and energy saving targets for existing projects

	Project	Project profile number	No of companies in target market	Energy savings (A) and required number of replications (B): Dec 85 A '000 tce/y	Dec 85 B No	June 88 A '000 tce/y	June 88 B No	Long term A '000 tce/y	Long term B No	Potential equipment suppliers
	LADLE AND TUNDISH PREHEATING PACKAGE									
1	Tundish drying — Allied Steel & Wire	107	8	0.2	1	0.6	2	4	8	Hotwork Ltd.
2	Ladle pre-heating — GKN Brymbo	175	12	2.0	2	30.0	5	67	12	Burner manufacturers.
3	Ladle pre-heating — BSC Stainless	145								
	STEEL REHEATING AND HEAT TREATMENT PACKAGE									Burner manufacturers including Hotwork, Stordy, Nuway Engineering,
4	Recuperative burners on a forge furnace — Sheffield Forgemasters Plc	24	15	7.0	13	7.7	14	16	25	Laidlaw Drew. In addition furnace contractors such
5	Planetary Mill furnace heat recovery — Ductile Planetary Mill Ltd.	9								as Priest Furnaces Ltd.
6	Recuperative burners on a reheat furnace - Dudley Port	25	50	230.0	40	260.0	50	370	75	ENCO panels from Encomech Engineering
8	Heated ENCO panels — Barworth Flockton	22								Services Ltd. Ceramic fibre insulation manufacturers and suppliers.
	DROP FORGING									
12	Bar heating fluidised bed furnace — Halladays Ltd.	164	40	2.5	12	6.0	30	16	80	Walkerdine Refractories Ltd.
			TOTAL	241.7	68	304.3	101	473	200	

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Section 2 The iron foundry industry

(Mr G C Bushell)

Energy use

In 1982, the iron casting industry used about 1.4 million tonnes of coal equivalent (Mtce)/year (36 PJ/year) of primary energy; this accounts for about 1% of the UK total primary energy demand. This energy is in the form of coke, gas, electricity and oil. In most iron foundries, metal melting accounts for about half of the total energy used. Cupola melting using coke is used in 70–80% of all foundries, with about 300,000 tonnes of coke being purchased for this purpose in 1982. Since 1980 there have been no new cupola melters, and electric induction melting now constitutes about 20–30% of the market. About 3 tonnes of iron are melted to produce 2 tonnes of finished castings. The 30% of returned scrap is in the form of 'runners and risers'[1] and machine swarf.

Of the 400 companies employing 25 people or more in the iron castings industry, some 300 produce castings entirely for sale to outside customers. The other 100 are tied companies producing for internal and external consumption. There are no accurate figures for the number of foundries that have closed but, between 1970 and 1982, iron castings output has declined from 3.83 to 1.47 million tonnes. In such an ailing industry, where energy represents 15–20% of product cost, little is being done to improve energy efficiencies.

The scope for improved efficiency

The energy conservation potential has been estimated at 400,000 tce/year. This saving can be achieved through:

- Improved housekeeping: switching off machinery and lighting, accurately measuring furnace bed coke and charge coke etc:
- Furnace Improvements:
  1) the introduction of divided or hot blast recuperative modification to cupolas;
  2) the use of waste heat for burner preheat or space heating;
  3) the injection of oxygen for charge coke savings;
  4) improved performance of electric furnaces:
- Yield Improvements:
- Improved Gas Cleaning.

Furnace improvements (1) and (2) are already taking place in the industry and current developments at the Electricity Council Research Centre (ECRC) at Capenhurst may help in item (4).

Improvements in yield can be achieved in both the melting and casting processes. By tight control of scheduling it may be possible to reduce the quantity of 'pigged' iron[2], which is normally about 10% in most foundries.

The largest improvements in yield can be made in the reduction of 'runners and risers' and the minimising of machining. Such scrap often constitutes about 25–30% of a casting and represents an energy loss of about 200,000 tce/year to the industry. Loss from castings can be reduced by better mould design and improved mould materials e.g. zircon sand or permanent moulds. There is a need for innovation in this area and attitudes within the industry need to be changed to achieve successful implementation of the emerging new technologies. Innovative work is currently being undertaken by BCIRA on casting practices within the industry.

There is a need for more energy efficient gas cleaning in the industry. It was estimated that about 25,000 tce/year could be saved by the introduction of low energy cyclone dust collection. A Research and Development project on this technology is currently under way in the non-ferrous sector, and possibilities exist for technology transfer to the iron castings industry.

It is important to note that the industry is currently experiencing a very severe recession in terms of demand for products which is resulting in minimal plant investment and virtually no opportunities for supporting demonstration projects. Much of the manufacturing capability is closely related to the automobile industry and there is therefore a need to identify wider markets. Export opportunities are limited because casting producers are typically of small size, and become uncompetitive if subject to additional transport costs.

Proposed programme and energy saving targets

Table 2.1 lists the proposed programme for the iron foundry industry: this list is not exhaustive, but it represents the main requirements currently recognised. There are only limited opportunities to improve energy efficiencies in this industry. It should be possible to implement projects in the fields of yield improvement, improved electric furnace insulation and fume arrestment. A great deal of effort will continue to be spent on acquiring projects in the areas of waste heat recovery and complete combustion of cupola waste gases. Much work on this technology is currently being performed abroad. There is a requirement for improving the dissemination of this information into the UK iron foundry industry from these UK and continental developments.

Current status of the programme

The three active demonstrations described in Table 2.2 have target savings of 153,500 tce/year which represents a significant fraction of the energy saving potential within the industry. There is a need for vigorous promotion of these projects with the help of organisations such as BCIRA. The feasibility study from a fourth project has been completed. The total cost to the Government of the demonstration projects that are active is £204,100.

Future plans

The development currently under consideration involves the possibility of extending low energy fume arrestment technology from the copper alloy to iron sector. It is hoped that this development will proceed in 1985 with target savings of about 12,000 tce/year.

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1 'Runners and risers' are pieces of metal (horizontal and vertical respectively) which occupy the channels in a mould which are necessary for molten metal flow. They do not form part of the finished casting, and are returned to the cupola for remelting.

2 'Pigged' iron is metal not immediately required for casting. It is removed from the cupola and cast into a crude mould (c. 1 m long). The ingot is put back into the cupola in the next melting cycle.

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Table 2.1 The iron foundry industry: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
	*	1	Permanent mould casting process — Russells	73.0	103.5	Dec 1984
	*	2	Energy reduction in metal melting — BCIRA	67.5	59.0	Sept 1984
	*	3	Cupola waste heat recovery - Hattersley Newman Hender	5.0	13.5	Dec 1984
	*	4	Improved insulation in electric melting — Stanton and Staveley	13.0	41.6	June 1985
	o	5	Fume arrestment technology	12.0	50.0	
	†		(Recovery of energy from cupola furnaces — SCM SpA)			
	†		(Energy recovery from gas exhaust of cupola furnaces — Teksid SpA)			
	†		(Iron casting with polystyrene foam — Teksid SpA)			
			TOTAL	170.5	267.6	

KEY * Existing project
o Required project
† EEC project

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Table 2.2 The iron foundry industry: Replication and energy saving targets for existing projects

	Project	Project Profile number	No of companies in target market	Energy savings (A) and required number of replications (B): Dec 85 A '000 tce/y	Dec 85 B No	June 88 A '000 tce/y	June 88 B No	Long term A '000 tce/y	Long term B No	Potential equipment suppliers
1	Permanent mould casting process — Russells	95	All Green Sand Iron foundries ~150 + some NF foundries ~30	6.9	3	10.4	5	73.0	30	Russell Cast-Tec (Intern) Ltd — sole licensees.
2	Energy reduction in metal melting — BCIRA	51	all iron foundries ~150	13.5	20	54.0	80	67.5	100	Not applicable.
3	Cupola waste heat recovery (feasibility study) — Hattersley Newman Hender	50	Iron foundry industry ~150	0.4	1	2.0	5	5.0	12	Esmil Ltd, also continental suppliers.
4	Improved insulation in electric melting — Stanton and Staveley	ø	All users of coreless induction furnaces	1.0	13	8.0	107	13.0	170	McKechnie Fibres Ltd.
			TOTAL	21.8	37	74.4	197	158.5	312	

ø Project profile not yet published

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Section 3 The non-ferrous metals industries

(Dr M Gettings)

Energy use

The non-ferrous industries (restricted here to aluminium, copper, lead, zinc and their alloys) account for about 4% of the primary industrial demand for energy i.e. 4.9 million tonnes of coal equivalent (Mtce)/year (130 PJ/year). Of this, aluminium uses 3.8 Mtce/year (100 PJ/year), copper 680,000 tce/year (18 PJ/year) and lead and zinc together 450,000 tce/year (12 PJ/year).

Aluminium

By far the largest energy use is associated with the electrolytic production of aluminium from the oxide which uses about 2 Mtce/year (52 PJ/year). The other energy intensive steps in the aluminium sector are in the melting and holding of the metal and in reheat and heat treatments in the fabrication process. Some 1.3 Mtce/year (34 PJ/year) is used for this purpose with the great majority being with fossil fired furnaces i.e. oil, natural gas or liquid gases. The use of electric melting has been greatly hindered by the high cost of the technology and problems with corundum formation.

The aluminium industry is at present going through a period of structural change. The formation of British Alcan Aluminium from BACO and ALCAN has resulted in a dominant domestic aluminium company. The combined company now controls between 70 and 75% of the UK's production capacity of rolled aluminium products, 65–70% of foil production, 62% of the smelting capacity and 35–40% of the aluminium extrusions. While the new company has had some rationalisation of its production facilities, these have been small as there is little overlap in the markets of the merged companies.

In the aluminium foundry industry the recession is still forcing closures although the rate appears to be slowing. The forced rationalisation has generally resulted in improvements in energy efficiencies in the remaining foundries and a greater awareness of the need to save energy. It is unfortunate that the capital investment is not available in many cases to implement many of the developing energy efficient technologies.

Copper

Energy use in the copper industry is dominated by the melting, holding, casting and heat treatment of the metal and its alloys. Again the predominant fuel used is either oil or gas (550,000 tce/year — 14 PJ/year) with electric melting for continuous casting only recently starting to be exploited. There are no major primary smelters for copper in the UK. In 1975 there were four secondary smelters in the UK and there are now two. As with aluminium, the foundry casting and semi-manufacturing section of the industry is made up of a large number of small companies (at present about 64). The fabrication industry is dominated by four big companies. These are: BICC Metal Ltd., Delta Metals Ltd., IMI Ltd., and McKechnie Metals Ltd. In both foundry and fabrication industries there has been a sharp decline in copper usage since about 1978 and output has fallen from 620,000 tonnes to 480,000 tonnes.

This reduction has been due both to the current world recession affecting areas such as house building, electrical power transmission etc and to the inroads made by other materials into the traditional copper markets. For example, both aluminium and fibre optics threaten to influence copper wire markets, while copper strip for radiator production is already being reduced because of aluminium. Some easing of the situation may occur due to the current higher base metal price of aluminium to copper. It has been estimated that, by 1985, 65% of all automobile radiators built in Western Europe will be in aluminium. The development of plastic tubes for hot water applications could have a major effect on copper production in the UK in the coming decade.

Zinc and lead

The production of zinc and lead has closely followed the downward trend of the economy. The primary production of these metals from the ore is undertaken by Commonwealth Smelters, Avonmouth, and secondary smelting is undertaken at four lead secondary refiners; no secondary zinc refining is done (except in-house at foundries). The major energy use in this sector is in melting and holding the metal for castings or (in the case of zinc) galvanising. The low energy use (compared with copper and aluminium) makes these industries a low priority area for exploitation. The demonstration projects in this area have straightforward replication potentials and will require little promotional effort.

The scope for improved efficiency

A previous strategy identified opportunities for improvements in the energy efficiency of the industry sector as about 62% for a 15 year period, divided into three categories: a) Good Housekeeping (17%), b) Technology Improvements (11%) and c) Manufacturing Process Changes (34%). Because of the rapid changes in the industry in the last two years and its current depressed state, it is not likely that many of the process changes will be implemented within the next decade. In the coming decade it is estimated that there is room for about a 40% improvement in efficiencies *if all the technologies and good housekeeping ideas are implemented.* For the dominant energy user, i.e. primary aluminium production, there appears little that can be achieved in the short term to improve energy efficiencies significantly. The electrolytic process of aluminium smelting dominates non-ferrous energy usage and this is not likely to be changed significantly in the coming decade in the UK within its two large primary smelters.

Further, the promise of aluminium recycling as a viable means of significantly improving energy efficiencies needs to be investigated. Scrap aluminium is either generated as 'new' scrap in the fabrication or foundry plant or as 'old' scrap from consumer products. Virtually all of the new scrap is already being recycled by the industry although there is still an estimated 150,000 tonnes of old scrap that is not as yet economically recoverable being in the form of film, foil or wire. A major study in the area is under way, however, to clarify medium to long term potentials for aluminium recycling.

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A speculative estimate of two areas which will result in improvements in energy efficiency in the non-ferrous sector are:

- improvements in melting, holding and heat treatment processes (300,000 tce/year), and
- the improvements in materials yield through the introduction of new technologies (300,000 tce/year).

The energy saving potential through improved furnace design and operation throughout the non-ferrous sector can be achieved through improved insulation, improved burner design, waste heat recovery, improved furnace controls and fuel switching.

In the aluminium industry, both increases in energy efficiencies and reductions in metal melt losses can best be achieved by the introduction of either electric melting or efficient heat recovery. Widespread introduction of either electric melting or, say, the regenerative burner technology in the UK may show savings of 100,000 tce/year. There is still significant potential for energy saving associated with other melting/holding technologies, however, and improvements in efficiency are currently being developed both through the Department of Energy's Research, Development and Demonstration Programmes (RD&D) and elsewhere.

Savings in yield are directly related to

a) melt losses, in which aluminium losses are effectively irretrievable,

and b) the generation of new scrap which has to be remelted and reworked.

In the fabrication industry it is estimated that energy equivalent to about 240,000 tce/year (6 PJ/year) is used in reprocessing this recycled material. In the area of extrusions, this figure is estimated to be 3 PJ while in the foundry industry an estimated 5 PJ is used. Yield improvements of 20% through, for example, better melting practices, improved casting technologies, better control of shape and gauge of strip, etc. would represent savings equivalent to 100,000 tce/year (3 PJ). It is estimated that similar savings could be made in the copper sector.

The energy use and potentials are summarised in Table 3.1.

Table 3.1

	Energy Use Mtce/y	Saving Pot. Mtce/y	Through Innovation Mtce/y	Through ED Mtce/y	Achieved Mtce/y
Aluminium	3.8	1.5	0.6*	0.38	0.03
Copper	0.68	0.15	0.10	0.04	0.01
Lead } Zinc }	0.45	0.1	0.06	0.03	—

*Additional savings are achieved through low technology improvements, good housekeeping etc.

Proposed programme and energy saving targets

The programme in the non-ferrous sector in the short term will be to encourage

1) improvements in the melting, holding and heat treatment of aluminium in both the foundry and fabrication industries and
2) improvements in metal yields in the foundry and fabrication industries in both the aluminium and copper industries (Table 3.2).

In the longer term any potential for aluminium recycling will be promoted through RD&D, and process changes to lower energy routes such as CONFORM-type extrusion technology, powder strip rolling or continuous casting of aluminium will be encouraged.

Current status of the programme

There are currently 19 demonstration projects in the non-ferrous sector funded through the Energy Efficiency Demonstration Scheme (Table 3.3) and three in the UK under the EEC scheme. In a further three projects, proposals have been received and two projects currently funded through the R&D scheme are expected to develop into demonstrations within the next 12 months. The target energy savings potential of the projects under way represent about 251,000 tce/year and the total cost to Government of £865,000.

Future plans

Significant effort needs to be placed on improving the efficiencies of aluminium bulk melters. A portfolio of demonstration projects is required which will offer to the industry a viable choice of efficient melting practices. More attention is required on improving yields especially in the fabrication of aluminium and copper products. A study is required in this area to highlight potential RD&D opportunities. Such developments should also have implications within the Ferrous Sector.

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Table 3.2 The non ferrous metals industries: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
ALUMINIUM — Furnace Development	*	1	Improved insulation on baleout furnace — Frys Diecasting	13.0	6.1	Sept 1984
	*	2	Immersion tubes for baleout furnace — BNF Metals	7.0	32.5	Dec 1984
	*	3	Electric holding baleout furnace — Frys Diecasting	9.0	35.5	Dec 1984
	*	4	Waste heat recovery from baleout furnace — Brycast	5.5	16.0	Dec 1984
	*	5	High velocity oil burner — Alcan (Latchford)	13.5	33.0	Sept 1984
	*	6	Waste heat recovery from immersed crucible furnace — Crompton Parkinson	16.0	18.0	Aug 1984
	*	7	Billet heating using porous burner — Aluminium Corporation Ltd	40.0	20.0	Dec 1984
	*	8	Flat flame burner on a baleout furnace — Alycast	10.0	20.0	May 1984
	+	9	Porous element holding furnace	10.0	20.0	May 1984
	†		(Novel electric holding furnace — Metal Box)			
	†		(Development of a high power Channel Furnace — ERC)			
	†		(Demonstration of high efficiency Induction Heater — British Alcan)			
				124.0	201.1	
— Materials Conservation	*	10	Flux/degasser on baleout furnaces — Diecasting Ltd	13.0	22.0	Sept 1984
	*	11	Charge pre-heating on reverberatory furnace — London & Scandinavian Ltd	15.0	38.5	June 1984
	*	12	Scrap pre-heating using waste heat recovery — Alcan (Latchford)	12.0	95.3	May 1985
	*	13	Recycling study — Warren Spring	30.0	10.0	Oct 1984
				70.0	165.8	
— New Processes	*	14	Two-wheel conform extrusion — Metal Box	5.0	80.0	
	o	15	Slurry casting	12.0	20.0	
	o	16	Liquid metal-feed conform	24.0	30.0	
				41.0	130.0	
			TOTAL ALUMINIUM	235.0	496.9	
COPPER	*	17	Continuous annealing of copper tube — IMI Yorkshire Imperial	2.0	53.5	Sept 1984
	*	18	Coal fired copper anode furnace — IMI Refiners	10.0	167.0	May 1984
	*	19	Waste heat recovery from copper melting furnace — IMI Yorkshire Imperial	12.0	38.5	May 1984
	+	20	Low energy fume arrestment	12.0	30.0	
	+	21	Conform extrusion from scrap copper	15.0	60.0	
				51.0	349.0	
ZINC	*	22	Immersion tube burners in zinc bath — Tinsley Wire	4.0	24.0	Dec 1984
LEAD	*	23	Waste heat recovery from lead melting furnace — Britannia Metals	14.0	87.0	Dec 1984
	o	24	Lead scrap refining	16.0	25.0	
				34.0	136.0	
OTHER NON FERROUS	*	25	Low energy heat treatment furnace — Spartan Redheugh	35.0	40.0	Sept 1984
	*	26	Swarf degreasing using waste heat — London & Scandinavian Ltd	15.0	38.5	Dec 1984
	o	27	Small continuous caster	10.0	—	
				60.0	78.5	
			TOTAL NON FERROUS	380.0	1060.4	

KEY * Existing project
+ Prospective project
o Required project
† EEC project

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Table 3.3 The non ferrous metals industries: Replication and energy saving targets for existing projects

	Project	Project profile number	No of companies in target market	Energy savings (A) and required number of replications (B)						Potential equipment suppliers
				Dec 85		June 88		Long term		
				A '000 tce/y	B No	A '000 tce/y	B No	A '000 tce/y	B No	
1	Improved insulation on baleout furnace — Frys Diecasting	116	~100	6.0	15	12.0	35	13.0	80	Morganite Thermal
2	Immersion tubes for baleout furnace — BNF Metals	136	~100	0.8	5	3.0	12	7.0	30	British Gas, Burns Engineering
3	Electric holding baleout furnace — Frys Diecasting	115	~100	2.0	6	4.0	12	9.0	35	Morganite Thermal
4	Waste heat recovery from baleout furnaces — Brycast	28	~100	0.6	3	2.0	5	5.5	15	Any sheet-metal working company
5	High velocity oil burner — Alcan (Latchford)	54	~10	2.0	3	6.0	6	13.5	10	Nu-way Energy, Hotwork Developments
6	Waste heat recovery from immersed crucible furnace — Crompton Parkinson	ø	~50	3.0	4	12.0	10	16.0	20	Nu-way Energy, Hotwork Developments
7	Billet heating using porous burner — Aluminium Corporation Ltd	186	~10	5.0	3	8.0	5	40.0	8	J E Mapplebeck — Shell
8	Flat flame burner on baleout furnace — Alycast	ø	~100	3.0	6	6.0	12	10.0	30	West Midlands Gas
10	Flux/degasser on baleout furnace — Diecastings Ltd	94	~100	2.5	8	5.0	15	13.0	40	Feslente Ltd
11	Charge pre-heating on reverberatory furnace — London & Scandinavian Ltd	92	~25	2.0	2	8.0	6	15.0	10	Wellman Selas Ltd. But others also could supply
12	Scrap pre-heating using waste heat recovery — Alcan (Latchford)	ø	~20	1.0	2	5.0	5	12.0	10	
14	Two wheel conform extrusion — Metal Box	148	~20	—	—	—	—	5.0	1	Holton Machinery, Babcocks Wire Extrusions
17	Continuous annealing of copper tube — IMI Yorkshire Imperial	93	4	—	—	—	—	2.0	1	ASEA (Sweden), Morganite Thermic, Ajax Magnothermic and others
18	Coal fired copper annode furnace — IMI Refiners	118	~10	5.0	2	7.0	3	10.0	6	Atritor Ltd and others
19	Waste heat recovery from copper melting furnace — IMI Yorkshire Imperial	53	~30	1.2	1	6.0	2	12.0	5	Cartwright & Speechley
22	Immersion tube burners in zinc bath — Tinsley Wire	151	15–20	0.6	2	1.5	3	4.0	4	BNF,Burns Engineering, MRS
23	Waste heat recovery from lead melting furnace — Britannia Metals	ø	5–6	2.0	1	5.0	3	14.0	5	FRG Engineering
25	Low energy heat treatment furnace — Spartan Redheugh	120	~80	8.0	5	15.0	20	35.0	40	Hotwork Developments, Nu-way Energy, Stordy
26	Swarf degreasing using waste heat — London & Scandinavian Ltd	126	10–20	2.0	2	6.0	4	15.0	8	APV, Mitchell Dryers Ltd
			TOTAL	46.7	70	111.5	158	251.0	358	

ø Project profile not yet published.

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Section 4 The engineering industry

(Dr N J Eyre)

Energy use

The total quantity of fuel and electricity consumed by the engineering industries in 1975 was approximately 8.97 million tonnes of coal equivalent (Mtce) (236 PJ). Although this is a substantial amount it represents only 10 per cent of the total annual consumption of the UK manufacturing industry. Since 1975 there has been a change in the industrial climate and between 1975 and 1980 the amount of energy used by industry fell by about six per cent.

To obtain absolute values for the energy consumed in 1982 by the industrial sectors covered by this report requires statistical analysis of the total industrial consumption. These data are not available and the absolute values for potential saving in energy and percentages quoted are those reported in an Energy Audit Series study of the industry which is yet to be published.

The scope for improved efficiency

The opportunities for making energy savings fall into the categories discussed below.

- *Factory services including space heating*
  Industrial Energy Thrift Scheme (IETS) Report No 21 identified factory services and space heating as functions that show most promise of saving energy in the mechanical engineering industry. It has been estimated that a national saving of 1.06 Mtce/year (28 PJ/year) would be a practical target saving for these services. This represents a 17.5 per cent saving on the amount used annually for this purpose.

  Demonstration projects relevant to saving energy on factory heating and services are discussed in Section 24 of this report.

- *Materials*
  Many of the traditional manufacturing techniques cause wastage of material in the form of swarf or croppings from forged parts. The energy used in the manufacture of this material is wasted and this is exacerbated by the energy used in removing the material to shape the finished product. A reduction in the amount of waste material can be achieved by forging and preforming products to close tolerances, thus minimising the amount of final machining, and by using materials that require less energy in their production.

  The diversity of products and materials used in the engineering industry is such that the initiative for changing to new materials and new manufacturing methods to conserve energy must come from within the industry. The need for changes in materials and manufacturing methods will often occur as a result of competition in the market. When decisions to make a change are made, energy conservation will be only one of many factors taken into consideration.

  The technical potential for saving energy by reducing the amount of waste material and by changing to materials that require less energy in their production is estimated to be 1.7 Mtce/year (45 PJ/year). This represents five per cent of the energy wasted by using traditional manufacturing methods and materials. The full technical potential saving in energy can be achieved only by adopting a variety of energy saving techniques. It is doubtful if changing one manufacturing technique or changing the material of a product will normally stimulate sufficient energy savings to merit Energy Efficiency Demonstration Scheme (ED) support.

- *Manufacturing Processes*
  The engineering industries use 75 per cent of the steel delivered to the whole of UK industry and they transform this steel into finished products. It is estimated that the adoption of energy saving techniques in manufacturing processes could offer a technical potential saving in energy of 760,000 tce/year (20 PJ/year). This represents 12.5 per cent of the energy consumed in manufacturing processes.

  Despite the diversity of products that is manufactured, all the industries within the engineering industry tend to use basic manufacturing processes such as machining, forging, welding, casting and heat treatment. The energy consumed by furnaces has been identified as a prime target for saving energy and a strategy relevant to this type of plant is discussed below.

  The engineering industries use other processes that are relatively energy intensive, for example chromium plating, zinc coating and degreasing. The energy used in these processes may be as electricity, gas or oil and opportunities exist for saving some of the energy consumed. Permutations of the different processes and the fuels used are, however, many and will require the application of many techniques to achieve the full national potential saving in energy. It is doubtful if a single technique could offer the potential saving of 10,000 tce required by the ED Scheme and it is unlikely that proposals to mount demonstrations would qualify for a grant. Techniques to save some of the energy in the above processes are kept under review by the Midland Electricity Board (MEB) and British Gas, and new techniques are developed in their laboratories. Tests are carried out in an industrial environment and if the project is successful it is given publicity by the appropriate supply authority.

- *Furnaces*
  The IETS Report No 21 and an Energy Audit have identified the recovery of waste heat, improvements in thermal insulation and improved control as ways of saving some of the energy used by all furnaces in the

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engineering industry. Depending on the furnace type and the energy conservation technique used, there is potential for saving up to 40 per cent of the energy consumed by some furnaces, with an estimated average of 30 per cent.

For the purpose of this review, furnaces used in the engineering industries are divided into the following two categories:

a) heat treatment furnaces — furnaces used for product quality processes such as carburising, nitriding, tempering and annealing etc.
b) general purpose furnaces — furnaces used for vitreous enamelling and heating steels prior to forging or rolling etc.

The annual consumption of energy in the heat treatment of metals in the engineering sector is approximately 300,000 tce (9 PJ) which is 3.7 per cent of the energy purchased by the mechanical engineering industries. The installed population of all types of heat treatment furnaces in the industry is approximately 21,500. Of this number, approximately half are heated by natural gas, 45 per cent by electricity and three per cent by other fuels. Table 4.1 gives a list of the heat treatment furnaces that are most commonly used and the approximate number of each type. In an attempt to provide an estimate of the potential for saving energy on each type of furnace, the approximate amount of energy consumed by each furnace type has been estimated. Based on this estimate and an average percentage saving in energy of 30 per cent, an approximate figure for potential energy saving has been derived.

Table 4.1 Heat treatment furnace population and estimates of energy consumption

Type of furnace	Industrial population	Total energy consumed (tce)	Technological potential based on 30% saving in energy (tce)
Batch box	12,300	171,000	51,300
Salt bath	3,200	45,000	13,500
Continuous	2,000	27,000	8,100
Others	4,000	90,000	27,000
TOTAL	21,500	333,000	99,900

General purpose furnaces such as those used for vitreous enamelling and all forging processes consume a considerable amount of energy. This type of plant is installed in many factories throughout the engineering industries and much desk research is necessary to determine the furnace population and the energy consumption.

Proposed programme and energy saving targets

Table 4.2 lists the currently funded and proposed projects in the programme for the engineering industry. A potential saving of 99,900 tce/year (Table 4.1) has been estimated for furnaces used on heat treatment processes. The replication target of 5,000 tce/year from existing projects 1 and 5 shown in Table 4.2 means that there is potential for saving a further 94,900 tce/year. If the ED criterion of a minimum 10,000 tce/year potential saving in energy per project is applied, there is scope for mounting more demonstrations on heat treatment furnaces. Experience in this field, however, has shown that in practice several techniques would need to be demonstrated and replicated to save the balance, and it is concluded that, in the future, it is possible that no single technique may show promise of saving the 10,000 tce/year required by the ED Scheme. For the same reason, it is likely that proposals for demonstrations on 'general purpose' furnaces may also fail to qualify for a grant.

New developments in furnace technology will not, however, be neglected because the Electricity Supply Industry and British Gas are actively engaged on projects aimed at saving energy on plants that use electricity and gas. The two Supply Boards develop equipment in their laboratories and, in co-operation with industry, try out the developments in an industrial environment. This work is complementary to that of the ED Scheme and gives publicity to projects that would not qualify for a grant because they have a relatively low national potential for saving energy.

The trend in demonstration projects on heat-treatment furnaces has been to make use of energy that would otherwise go to waste. It is proposed that future demonstrations should be aimed at reducing the amount of energy used by processes. An example of this is heating metal bars by direct electrical resistance heating. The Midland Electricity Board developed a prototype machine and a manufacturer is currently developing direct electrical resistance machines for industrial applications. This project is receiving financial support from the Department of Trade and Industry Support for Innovation Scheme.

Current status of the programme

Table 4.2 shows the five demonstrations on furnaces that are in progress and the cost to Government for each project. The total funding for these five projects is £92,500 and the total target saving in energy through replication is 10,000 tce/year. Three of the projects are relevant to furnaces in the 'general purpose' category and two are in the 'heat treatment' category. The total annual target saving by replication of projects in each category is 5,000 tce.

The technologies demonstrated are:

Project No 1 Heat recovery for space heating
Project No 2 Heat recovery for process drying
Project No 3 Heat recovery for process drying
Project No 4 Furnace with low thermal mass insulation
Project No 5 The application of a recuperator on a rotary drum furnace.

Projects 1, 2, 3 and 4 have been fully monitored and final reports are being prepared. Monitoring prior to conversion has been completed on Project 5. The targets for energy saving by replication are shown in Table 4.3.

Future plans

Due to technological changes within the vitreous enamelling industry the energy savings by replication of projects 2 and 4 will not be as great as was originally hoped and a large promotion effort will not be required. Monitoring reports on the remaining projects will become available during 1984 and suitable promotional activities will then be organised.

Many energy efficient technologies remain to be demonstrated and new projects will be initiated in areas where sufficiently large replication targets justify them.

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Table 4.2 The engineering industries: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
HEAT TREATMENTS USED IN MANUFACTURING PROCESSES						
Waste heat recovery	*	1	Heat recovery for space heating — Morse Chain	1	13.5	
	*	2	Waste heat used for enamel ware drying oven. ED monitoring — Thorn EMI	—	14.6	
	*	3	Waste heat used for enamel ware drying oven. ED monitoring — Smith & Wellstood	2	12.0	
Improved thermal insulation	*	4	New furnace with low thermal mass insulation — Edward Curran	3	32.2	
Improvements in combustion control	*	5	Recuperators on rotary drum furnace — Metabrasives Ltd	4	20.2	
Reduction in energy requirement	†		(Carburising at elevated temperatures — Lucas Research Centre)			
	o	6	Optimising depth of surface heat treatment	Market survey required	EECC	
				10	92.5	
INJECTION MOULDING						
Waste heat recovery for process drying	*	7	Waste heat from machine cooling water to dry and preheat plastic granules	Market survey required	EECC	
METALS & PRODUCT STORAGE						
Dehumidifying store rooms	o	8	Installation of plant to reduce the humidity in store rooms in place of conventional heating	Market survey required	EECC	
SURFACE COATING OF METALS EXCLUDING PAINT						
Waste heat recovery						
Improved production techniques	o	9	Potential for saving energy in this sector of industry requires further study	Market survey required	EECC	
Reduction in energy requirements						
			TOTAL	10	92.5	

EECC — Existing ETSU consultancy contract

KEY * Existing project
o Required project
† EEC project

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Table 4.3 The engineering industries: Replication and energy saving targets for existing projects

	Project	Project profile numbers	No of companies in target market	Energy savings (A) and required number of replications (B)						Potential equipment suppliers
				Dec 85		June 88		Long term		
				A '000 tce/y	B No	A '000 tce/y	B No	A '000 tce/y	B No	
1	Heat recovery for space heating — Morse Chain	38		—	—	—	—	1	4	
2	Waste heat used for enamel ware drying oven — Thorn EMI	134		—	—	—	—	—	—	
3	Waste heat used for enamel ware drying oven — Smith & Wellstood	152		—	—	—	—	2	4	
4	New furnace with low thermal mass insulation — Edward Curran	63	2	1.4	2	2.3	4	3	5	Furnace equipment and ceramic fibre insulation manufacturers
5	Recuperators on a rotary drum furnace — Metabrasives Ltd	154		—	—	—	—	4	15	Furnace equipment manufacturers
			TOTAL	1.4	2	2.3	4	10	28	

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Section 5 Machinery drive technology

(Dr N J Eyre)

Energy use

For the purpose of the Energy Efficiency Demonstration Scheme (ED) the boundaries of Machinery Drive Technology can be limited to an estimated 18M machines that are powered by electric motors rated up to 150 kW. Above 150 kW power rating, machine and machinery drives tend to be designs in which specialists take cognisance of efficiency and energy costs and there is little if any scope for mounting demonstration projects on machines of this size. It is possible that companies may wish to submit proposals for demonstrations on machines above 150 kW rating but it is more than likely that most of these will fail to offer a sufficiently large target energy saving per year to merit a Government supported demonstration. Surveys carried out by various organisations suggest that motive power consumes between 60 and 75 per cent of the total industrial electrical energy.

In a study carried out by ERA Technology Ltd it is estimated that the total industrial motive power consumption for 1977 was 65,800 GWh. Motors up to 150 kW rating consume about 76 per cent of the total motive power and motors in the range 0.75–37.5 kW consume about 54 per cent of the total motive power.

An estimate of the distribution of motive power according to application is shown in Table 5.1

Table 5.1 Estimated UK motor electricity consumption for 1977 by application

Application	Electricity consumption GWh	Percentage of motive power electricity consumption
Pump	27,300	41.5
Fans	12,600	19.2
Compressors	9,100	13.8
Machine tools	2,500*	3.8
Others	14,300	21.7
Total	65,800	100

*Machine Tool Industries Research Association estimate. For other applications the following operational hours/year are assumed.
a Pumps, compressors and others — 300 h/year, and
b Fans — 2,500 h/year.

The scope for improved efficiency

The techniques required to save energy in machinery drives are well known to industry and it is considered that significant energy savings may be stimulated by the promotion of efficient drive systems. However, this does not preclude the submission of proposals for demonstration and these would be considered on their merits.

The techniques that offer the greatest potential for saving energy in motive power can be classified under five main headings.

- Improving the efficiency of a.c. electric motors: national potential saving in energy 200,000 tonnes of coal equivalent (tce)/year (primary) (440 GWh/year).
- The use of variable speed control on pumps, fans and compressors: national potential saving on energy 30,000 tce/year (primary) (66 GWh).
- Reducing the energy consumed by motors that are operating at less than full load capacity: national potential saving in energy 300,000 tce/year (primary) (660 GWh).
- Improvement in the maintenance of vee belt transmissions or using flat belts instead of vee belts: national potential saving in energy 200,000 tce/year (primary) (440 GWh).
- The use of a centralised hydraulic pump system to drive a multiple number of machines that are powered by hydraulic motors. The application of this technique to injection moulding machines could show a national potential saving in energy of 150,000 tce/year (primary) (344 GWh). Extending the use of centralised hydraulic systems to power other types of machines would show a significant national saving in energy.

Improving the efficiency of a.c. electric motors

The criteria for increasing the efficiency of electric motors are well known and a range of motors that have efficiencies higher than the standard range is available in the UK. High efficiency motors carry a premium on first cost and this can normally be recovered by a saving in energy costs after about 5000 hours in operation. There is small, if any, risk involved in using high efficiency motors and it is unlikely that proposals for demonstrating their potential for saving energy would qualify for a grant under the ED Scheme.

Variable speed control

The application of invertor and thyristor controls to change the speed of pumps, fans and process machines is well established in industry. This control technique is, however, seldom used on air compressors or refrigeration plant.

A demonstration project in which an a.c. invertor is used to vary the speed of an a.c. induction motor on a reciprocating air compressor is currently in progress. Proposals for demonstrating variable speed drive on a screw compressor and a refrigeration plant should be pursued.

New developments in Reluctance Motors appear to be an attractive alternative to a.c. invertor speed control units. It is claimed that sensors and logic control circuits in the new Switched Reluctance Motor enable speeds to be varied with minimum reduction in efficiency. The motor was developed at Leeds and Nottingham Universities and is marketed by Tasc Drives Ltd under the name of Tasc's Oulton Drive. Demonstrations using this new development, for example on pump and fan installations, would enhance their penetration into the market and save some of the energy that is currently wasted by throttling and damper controls. ERA Technology Ltd

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have estimated that throttling losses can account for 15–20 per cent of the input power.

Electric motors operating below full load capacity
Electric motors are often oversized for the duty that they have to perform. It has been estimated that the average load on electric motors used in industry is about 60 per cent of full load capacity and a large proportion operate at well below 40 per cent full load. Power factor control units (power saving devices) capable of reducing the energy wasted by motors operating at less than full load capacity are currently gaining a market.

Under the auspices of the ED Scheme the Department of Trade and Industry is contributing to a multiclient project to evaluate the performance of the power factor control units that are currently available. This project is mounted by the ERA Technology Ltd and a report on their findings was published in February 1984. Motor users in industry are interested in these units but they appear to have reservations about the savings that may be achieved from these relatively new devices.

Vee belt and flat belt transmissions
Small scale laboratory tests have shown that the modern flat belt is on average 3.5 per cent more efficient than a comparable vee belt.

The barrier to the wider application of the modern flat belt is possible due to the image generated by traditional leather belts and the lack of British Standards relevant to the modern flat belt.

The national technological potential for saving energy by using modern flat belts is significant but it is unlikely that this would be achieved by the publicity given to a small number of demonstrations.

The Energy Efficiency Office's (EEO) interests in saving energy can best be served by giving publicity to the savings that can be achieved by maintenance of existing vee belt transmissions and by the use of modern flat belts.

Companies that are interested in saving energy on belt transmissions can, at relatively low cost, improve on maintenance schedules. To overcome inhibitions about the use of modern flat belts, companies would need to make only a small capital investment to test this type of belt on one or two of their installations.

Centralised hydraulic systems
With financial assistance from the Mechanical Engineering and Machine Tools Requirements Board, Chloride Lorival and the National Engineering Laboratory have developed a centralised hydraulic system which can be used in place of conventional a.c. motors that power injection moulding machines. Currently this system is installed in an industrial environment and is driving five machines.

Chloride Ferrostatic, an associate company of Chloride Lorival, aims to market centralised hydraulic systems based on the developments carried out in the above project. They plan to offer a service of design, installation and commissioning to meet customer requirements on injection moulding machines.

The investment required for an average size of installation is about £100,000. In the present industrial climate the injection moulding industry appears to lack the capital for converting to centralised hydraulic systems. The penetration of this technology would be enhanced by mounting a demonstration with Chloride Ferrostatic's first customer acting as the host.

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Table 5.2 Machinery drive technology: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
VARIABLE SPEED DRIVES	*	1	Variable speed drive powering a reciprocating air compressor — Peglers Ltd	30	33	
	o	2	Variable speed drive powering a rotary screw compressor		35	
	o	3	Variable speed drive powering refrigeration plant		35	
POWER SAVING UNITS	o	4	Demonstrations with a c induction motors up to 10 kW	50	25	
	o	5	Demonstrations with a c induction motors from 10–100 kW	50	25	
CENTRALISED HYDRAULIC SYSTEM	o	6	Demonstration on injection moulding machines	Survey initiated 50	EECC* 50	
			TOTAL	180	203	

* EECC: Existing ETSU consultancy contract

KEY * Existing project
o Required project

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Proposed programme and energy saving targets

Table 5.2 identifies three areas in which demonstrations would assist the penetration of energy saving techniques on machinery drives. The approximate expenditure by Government is also listed. At present only project No 1 is in progress. Initial monitoring on this project highlighted problems associated with the overall control of a compressor plant, and a novel control system has been incorporated in the demonstration. The novelty of variable speed drive on compressor and refrigeration plant is such that projects Nos 2 and 3 are unlikely to come forward until project No 1 is seen to be successful.

The future for mounting demonstrations using power factor control units on a.c. induction motors (projects Nos 4 and 5) is dependent on the results of the ERA study.

For project No 6 a survey is required to establish the national technological potential for saving energy with centralised hydraulic systems. The results of the survey can then be used as a guideline in assessing demonstration project proposals.

The total energy saving target shown in Table 5.2, which could be achieved by widespread replication of successful demonstrations of all these projects, is estimated to be 180,000 tce/year (primary) (370 GWh/year).

Under the auspices of the DTI Industrial Energy Thrift Scheme, ERA Technology Ltd have prepared a set of slides and a recorded tape commentary on the efficient use of electric motors. Copies of this presentation, either in its present form or as a video tape, should be presented at appropriate seminars and conferences. Copies should also be made available for the use of Regional Energy Efficiency Officers and Energy Managers' Groups.

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Section 6 High temperature waste heat recovery

(Dr M Gettings)

The technology

High temperature waste heat (HTWH) can be considered as the heat contained in gases which escape at above 400°C from manufacturing processes. This temperature can be considered as a dividing line as certain heat recovery technologies are inoperable above this temperature. Estimates of waste heat recovery potential vary widely and the last known reliable estimate was compiled (Energy Paper No 32) in 1978. There exists little reliable data on either the current waste heat quantity or its potential recovery; this lack of knowledge is due to its disaggregated nature.

A study on HTWH commissioned by the Energy Technology Support Unit on behalf of the Department of Energy, is just about to be published* and will report on the heat recovery potential from the six major energy consuming industry sectors. In these sectors some 3.8 million tonnes of coal equivalent (Mtce)/year are currently being lost through both clean (1.6 Mtce/year) and dirty (2.2 Mtce/year) gas emissions above 400°C. The industries covered by the report are iron and steel, iron castings, aluminium, copper, glass, refractories, ceramics and bricks. This study quantifies the heat lost in these industries and outlines the technologies which are available for economic heat recovery. All the technologies discussed rely on a transfer of heat from either a gas/gas or gas/liquid heat exchanger or on the direct transfer of heat to pre-heat furnace or oven charge.

The high capital cost of most HTWH technology, coupled with the current recession in high temperature industries, has resulted in a slow take-up of the technology and a weak UK supply industry. Within this supply industry, there are some 16 companies manufacturing heat recovery equipment i.e. heat wheels (2), recuperators (13) and regenerators (2), and about 40 companies manufacturing other types of heat exchanger. The majority of these 40 companies are producing equipment for low temperature applications.

The larger number of companies manufacturing recuperation equipment reflects the use of this technology in pre-heating combustion air applications. Pre-heated hot air, from a waste gas recuperator, mixed with fossil fuel prior to combustion is becoming a major use for waste heat. The use of self-contained recuperative burners, which has only become viable in the last 10 years, offers the advantages of direct fuel savings and a marrying of waste gas arising and supply requirements. The technology is limited, however, to clean or nearly clean gas applications and temperatures below about 1200°C.

There is at present only a limited amount of research and development work in HTWH recovery. The weakened state of the supply industry has meant that product development has relied heavily on foreign expertise. With the current state of UK industry, low cost, high efficiency (therefore low payback) devices are often considered as being the only option for investment. It may well be that the highly expensive, massive heat recovery units, while having acceptable paybacks by saving large quantities of heat, are not liable to represent a good investment decision in the present economic climate.

An advance in burner technology has recently been announced by British Gas. This development is of a ceramic regenerative burner which, by the short term storage of waste heat (1–2 minutes), has allowed burner efficiencies to be boosted to 80–90%: furnace efficiencies are expected to be 50–70%. The burner, which is under further development by British Gas and Hotwork, has the potential to operate in dirty gas environments and has already operated continuously for several months at 1200°C in clean gases. This relatively low cost device should make a major impact on waste heat recovery potential in the next 5 years.

Proposed strategy for high temperature heat recovery

Until the above-mentioned report is finalised and information is gained from studies in other industry sectors e.g. Chemicals Industry, a comprehensive strategy cannot be formulated in this area to advance a programme of Research, Development and Demonstration in high temperature heat recovery. To date all of the HTWH recovery demonstration projects have been the responsibility of project officers on a sectoral basis (Table 6.1) and no overall review of the impact of the Energy Efficiency Demonstration Scheme (ED) on heat recovery has been attempted. Despite these limitations, certain facts are emerging and these can be summarised as:

- The recovery of heat from clean gases is being achieved in this present economic climate by the application of low cost retrofit technology.
- The ceramic regenerative burner should slowly displace self recuperative burners in applications where waste heat is emitted above 800°C.
- There is no low cost, high efficiency, heat exchanger which operates reliably between 800 and 1300°C.
- There exists no technology, apart from charge preheating, which can handle dirty waste gases economically.

From the above observations an outline plan for the development of HTWH recovery can be formulated. This strategy will, in the clean gas area,

a) encourage the development of a low cost, low maintenance, high efficiency recuperator for use with hot clean gases. Such a recuperator would allow the recuperative burner to compete with the regenerative burner at high temperatures,

b) demonstrate further the economic advantages of charge preheating in various areas of the metals sector,

c) promote the use of the ceramic regenerative burners in those industries where further Research and Development of the technology is not required.

*Waste Heat from High Temperature Industrial Processes: Sources and Recovery Potential. L E Häseler et al. Harwell Report G 2868.

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d) Promote Research and Development to improve recovery efficiencies for gases between 500 and 800°C.

For dirty gases, the strategy will

e) attempt to achieve a better understanding of the contamination present in hot gas streams on an industry basis. This will allow

f) developments in heat exchanger materials, geometries and methods of use to be matched to the industry concerned.

With this knowledge it may be that the use of compact regenerator beds will yield not only a method of heat recovery but also a method for gas cleaning.

Future plans

More information is required on the specific nature of dirty waste gases for each industry sector. This information can then be used to formulate an R, D and D programme for the development of technology to recover heat from dirty waste gas streams. Efforts will be made with the help of British Gas and Hotwork Developments to extend the use of regenerative burner technology into the dirty gas area. An examination of the failures of current technology for dirty gas applications will reveal areas in which further development work is necessary.

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Table 6.1 High temperature waste heat recovery: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
IRON AND STEEL	*	1	Use of regenerative burners on a heavy forge reheating furnace — Sheffield Forgemasters Plc	50.0	52.0	Sept 1984
	*	2	Use of regenerative burners on a continuous heat treatment furnace — BSC Stainless	50.0	176.0	Sept 1984
	o	3	Use of regenerative burners with low calorific gases	100.0	150.0	
	*		(Planetary mill furnace heat recovery — Ductile Planetary Mill Ltd)	(370.0)	(18.0)	
	*		(Recuperative burners on a continuous reheating furnace — Dudley Port)		(22.0)	
	*		(Self recuperative burners on a heavy forge furnace — Sheffield Forgemasters Plc	(16.0)	(46.0)	
	*		(Recuperative burners for ladle pre-heating — BSC Stainless)	(67.0)	(15.0)	
	*		(Ladle pre-heating — GKN Brymbo)		(31.0)	
NON-FERROUS	o	4	Use of regenerative burners for bulk melting of aluminium	50.0	80.0	
	o	5	Use of regenerative burners for bulk melting of copper	60.0	90.0	
	*		(Swarf degreasing using waste heat — London & Scandinavian Co Ltd)	(15.0)	(38.5)	
	*		(Heat recovery from aluminium melting for air pre-heat and stock drying — London & Scandinavian Co Ltd	(15.0)	(38.5)	
	*		(Waste heat recovery from immersed crucible furnace — Crompton Parkinson)	(16.0)	(18.0)	
	*		(Use of immersion tubes for holding of molten aluminium — BNF Metals)	(7.0)	(32.5)	
	*		(Use of baleout furnace exhausts for space heating — Brycast)	(5.5)	(16.0)	
	*		(Use of ceramic cube recuperators for low energy plate heat treatment furnace — Spartan Redheugh)	(35.0)	(40.0)	
	*		(Use of heat recovery from copper melting furnace for air pre-heat and space heating — IMI Yorkshire Imperial)	(12.0)	(38.5)	
	*		(Waste heat recovery from lead melting furnace — Britannia Metals)	(14.0)	(87.0)	
ENGINEERING	o	6	Use of regenerative burners on a batch heat treatment furnace	100.0	40.0	
	*		(Use of heat treatment furnace burn off for space heating — Morse Chain)	(1.0)	(13.5)	
	*		(Use of waste heat from continuous furnace for enamel ware drying ovens — Thorn EMI	—	(14.6)	
	*		(Use of recuperative burners in a rotary drum furnace — Metabrasive)	(4.0)	(20.2)	
GLASS	o	7	Use of regenerati e burners for bulk melting of glass	200.0	100.0	
	*		(Recuperative b ners on the working end of a glass tank — Beats -Clark)	(2.0)	(5.0)	
BRICKS REFRACTORIES	o	8	Use of regenerative burners on intermittent kilns	60.0	40.0	
	*		(Heat recovery from intermittent pottery kilns — A G Hackney & Co Ltd)	(3.0)	(19.0)	
	*		(Heat recovery from a Scotch brickmaking kiln — W T Lamb & Sons)	(2.0)	(16.0)	
	+	9	Use of regenerative burner on intermittent brick kiln	25.0	65.0	
IRON FOUNDRY	*		(Waste heat recovery from iron foundry cupolas — Hattersley Newman Hender)	(5.0)	(13.5)	
			TOTAL	695.0	728.0	

KEY * Existing project
o Required project
+ Prospective project

NB Items and values in brackets are not included in the above totals. They are incorporated in the figures for other technologies elsewhere in the document.

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Section 7 High temperature process insulation

(Dr M Gettings)

The technology

High temperature insulation materials are fabricated as refractory bricks, insulating castables and ceramic fibre. The first two structures have been used for many years and are only now being slowly replaced by ceramic fibre insulation. Their decline in sales over the past 5 years is partly due to the switch to ceramic fibre and partly due to the recession in the furnace operating industries.

The UK market of 2,500 tonnes of ceramic fibre in 1979 has not changed appreciably and sales in 1981 were only marginally greater. Output of ceramic fibre has increased, however, due to increased export of the material. The UK supply industry is highly concentrated and UK production of both alumino-silicate and alumina fibres is growing. Imports of fibres into the UK are virtually zero. The close technical links between some UK manufacturers have strengthened the UK base to resist imports and improve exports. There has also been a growth in the UK module market. Fibre assembled into panels or tiles is becoming increasingly popular and there is a strong demand for this product both in the UK and abroad.

Current developments in the market are towards higher temperature and more chemically resistant materials for both direct insulation applications and for incorporation into waste heat recovery and burner technologies. There are developments in improving the emissivity of furnace linings by coating and by refractory improvements. Furnace designs are being modified to take advantage of low thermal mass insulating panels and rapid heating furnaces are being constructed in all furnace-using sectors of industry.

The scope for improved efficiency

The Department of Energy's study[1] completed in November 1981 revealed an energy saving potential for high temperature thermal insulation of 1 million tonnes of coal equivalent (Mtce)/year (25 PJ/year) with 60% being attainable with current materials. Since that time the current recession has both hindered investment and reduced high temperature process operations. It is probable that the potential for improved efficiency has not been radically altered from the above figure. Many of the applications for high temperature insulation in clean environments are now under way either with or without the support of the Energy Efficiency Demonstration Scheme. Effort needs to be expended, however, on higher temperature applications and on insulation in dirty furnace environments. Developments under way through the Department of Energy's Energy Conservation Research and Development Scheme should assist in promoting these applications. The strength of the insulation industry has helped to promote a positive attitude in end users towards using insulating materials for energy conservation. This attitude needs to be encouraged.

1 High Temperature Thermal Insulation Usage in the UK Process Industries ETSU 1981.

Proposed programme and energy saving targets

The Department of Energy study estimated savings of 600,000 tce/year using existing insulation technology and 400,000 tce/year using new technology. The High Temperature Insulation sector is managed on a sectoral basis and there are currently some five demonstration projects whose main novelty value is in the use of high temperature insulation (Table 7.1). A further nine projects utilise high temperature insulation as part of their rationale for energy savings. There is currently only one project (J E Heath) which is being managed under the banner of High Temperature Insulation. It is estimated that the energy savings eventually possible through the demonstration scheme in the area of high temperature insulation are approximately 100,000 tce/year. The programme will be expanded slightly to encompass the introduction of high emissivity coatings. A study will be undertaken in this area to evaluate the impact of this development on insulation performance.

Table 7.1 High temperature process insulation: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
	*	1	Ceramic fibre insulation — J E Heath	—	15.7	May 1984
	o	2	High emissivity coatings	80.0	10.0	
	*		(Enco panels on air cooling system — Barworth Flockton)	(13)	(57)	
	*		(Low thermal mass muffle kiln — Edward Curran Ltd)	(3.0)	(32.2)	
	*		(Baleout furnaces with low thermal mass insulation — Frys Diecasting Ltd)	(13.0)	(6.1)	
	*		(New insulating refractory bricks in a cement kiln — Tunnel Cement Ltd)	(25.0)	(59.0)	
			TOTAL	80.0	25.7	

KEY * Existing project
o Required project

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Section 8 The food processing industries

(Dr A W Deakin)

Energy use

The food processing industries are collectively amongst the larger consumers of energy in the UK accounting for around 9% of the total energy consumed by industry or 3% of the total energy purchased by final users in the country (on a heat supplied basis). Current consumption of primary energy is around 9 million tonnes of coal equivalent (Mtce)/year (245 PJ/year) with the largest fuel input in the form of oil. The mix of energy purchased was oil 46%, gas 30%, electricity 14% and coal 10% in 1981.

The distribution of energy consumed within the sector in 1979 is given in Table 8.1 together with the estimated sales values, excluding tax.

Table 8.1 Food processing industries: Distribution of energy used in 1979

Sector	Sales Value £ million	Energy Purchased (heat supplied basis) PJ
Brewing and malting	3,310	26
Spirit distilling	1,800	27
Baking	3,380	26
Dairy	3,550	24
Preserved foods	4,000	21
Sugar	760	22
Sugar confectionery	1,880	11
Animal food	2,770	12
Oils and fats	960	9
Miscellaneous foods	3,580	27

Energy use is highly diverse both in the nature of the products and process and in the pattern of energy use. Energy costs as a percentage of total operating costs are low at around 2 or 3% in most sectors. However, as a percentage of profit, energy costs are important throughout the entire industry.

The scope for improved efficiency

Three reports in the Energy Audit Series and one in the Industrial Energy Thrift Scheme Series (IETS) have been published: No. 3, The Dairy Industry (1978); No. 8, The Brewing Industry (1979); No. 15, The Malting Industry (1981); No. 32; The Meat, Fish, Fruit and Vegetable Processing Industries (IETS 1983). These reports have identified the longer term energy conservation potential for the industries covered as 32% overall. The breakdown of the savings identified is given in Table 8.2. Further IETS reports relating to food processing industries are due for publication in 1984.

It is already clear that the major opportunity for improved energy efficiency is through technology improvements to existing plant and it is from under this heading that many of the projects appropriate for Energy Efficiency Demonstration Scheme (ED) support can be expected to emerge.

Proposed programme and energy saving targets

The energy efficiency projects currently supported by the ED Scheme and the EEC Energy Conservation Demonstration Scheme are listed in Table 8.5.

Table 8.2: Long term energy conservation potential

Category	'000 tce/year				
	Brewing	Malting	Dairy	Preserved Foods	Total
Good housekeeping	80	60	130	70	340 (11%)
Technology improvements	240	220	80	50	590 (20%)
Process change	—	—	20	—	20 (1%)
TOTAL	320	280	230	120	950 (32%)

The estimated technological potential energy savings associated with the food processing industries as a whole are summarised in Table 8.3.

Part of the technological potential will be achieved using conventional, proven technology and part using innovative technology in the medium to long term.

It is not possible to approach the food processing industries as a whole to discuss their needs. Most of the sectors operate entirely separately from one another. The sector specific projects where an impact is most likely to be made in terms of stimulating energy saving using the ED Scheme are mainly confined to the large energy consuming sectors such as sugar, brewing and malting, spirit distilling, baking, dairy and preserved foods.

Table 8.3 Summary of potential energy savings

Sector	Technological Potential Energy Savings Mtce/yr	Percent Total Energy Use by Food Industries
Brewing	0.32	3%
Malting	0.28	3%
Spirit distilling	0.34*	4%
Baking	0.29*	3%
Dairy	0.23	2%
Remaining sectors	1.20*	13%
TOTAL	2.66	28%

*Estimated — need firmer market data to assess

The sugar sector is special in that it is divided into two parts (beet processing and cane refining) and each is the monopoly of one company (British Sugar and Tate and Lyle respectively). Projects in this sector are therefore inappropriate for UK support and ED proposals will not be forthcoming. Nevertheless the EEC favours projects in this sector as will be seen in Table 8.5.

Priority will be given therefore to the remaining five large energy consuming sectors which each account for 1 Mtce/year or thereabouts: brewing and malting; spirit distilling; baking; dairy and preserved foods. Together these

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accounted for 60% of the total energy purchased by the food processing industries in 1979.

For the rest of the industry the sectors tend to be smaller. Three sectors can be identified which each account for 500,000 tce/year or thereabouts: sugar confectionery; animal feed; oils and fats. The remaining 1 Mtce/year or so is consumed by the miscellaneous food processors. Opportunities where an impact can be made using the ED Scheme are likely to be fewer, less easy to identify and will need firmer market data to assess.

Current status of the programme

There are 25 existing projects in the Food and Drink Sector including those shown in Table 8.5 as being classified under the technologies elsewhere in the document, at a cost to ED of £1.9 million with target energy savings of 0.4 Mtce/year. The distribution of projects by sector is given in Table 8.4 and details of energy savings in Table 8.6.

Many practical problems have been encountered by host companies and suppliers in implementing the demonstration projects, so the benefits are not being realised as rapidly or extensively as possible. In spite of this 12 projects have known replication spread across the brewing, malting, distilling, baking and dairy sectors.

Table 8.4 Distribution of projects by sector

Sector	Number of Existing ED Projects	Target Energy Savings '000 tce/year	Cost to ED £'000
Brewing	3	21	58
Malting	6	97	652
Spirit distilling	7	185	622
Baking	5	48	361
Dairy	3	34	150
Other sectors	1	17	70
TOTAL	25	402	1,913

*excluding broader industrial savings

Future plans

New projects will be actively sought to complement existing projects in the brewing, baking and dairy sectors and to open up the preserved food sector where there are no projects as yet.

A report on energy usage by refrigeration plant and the scope for encouraging improved energy efficiency will be completed in 1984 and it is expected that this will identify areas where refrigeration based projects could usefully be undertaken.

It is intended that activity in marketing and promoting of existing projects will concentrate on the spirit distilling field in 1984 with promotion continuing in other areas.

Table 8.5 The food processing industries: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
BREWING						
Effluent heat recovery	*	1	Keg washing/filling heat recovery — Scottish & Newcastle	6	23	July 1981
	*	2	Heat recovery from effluent/fridge plant feasibility — Bass	—	8	
Wort boiling	*	3	Hot water from recovered heat — Ind Coope	15	27	Spring 1984
				21	58	
MALTING						
Heat recovery	*	4	Run around coil — Associated British Maltsters	97	30	July 1981
	*	5	Run around coil — Pauls & Sandars		44	July 1981
Heat pump	*	6	Gas engine heat pump — Associated British Maltsters (Louth)		177	Mar 1982
	*		(Heat pump with power generation — Associated British Maltsters)	—	(176)	
	*		(Gas engine heat pump in a maltings — Pauls and Sandars)		(195)	
	†		(Electric heat pump — Alstham)			
	†		(Engine driven heat pump — An Foras Taluntais)			
	†		(Heat pump/supplementary firing — Weissheimer)			
Waste as fuel	*	7	Barley dust as fuel — Associated British Maltsters	—	30	
				97	281	
SPIRIT DISTILLING						
Malt whisky	*	8	Automatic control of stills — Bells	20	37	Nov 1983
	*	9	Thermocompression on condensers — Morrisons	36	81	Spring 1984
	*	10	Condenser heat for pot ale evaporation — Bells	22	99	May 1982
	*	11	Reject condenser heat for horticulture — Morrisons			
			Flue gas waste heat recovery and stills charge pre-heat — Morrisons	11	182	June 1982
	*	12	Waste heat for distillation residue evaporation — Bells	46	63	
Grain spirits	*		(Steam turbine mechanical vapour recompression — Inverhouse Distillers Ltd)	(40)	(86)	
	*	13	Use of flash steam in cereal cooking — Grants	10	74	Sept 1981
				145	536	

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Table 8.5 The food processing industries: Proposed programme (continued)

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
FOOD BAKING						
New process plant	*	14	Lanham/Tweedy energy efficient system — Family Loaf Bakery	20	116	Mar 1982
	*	15	Baker Perkins microprocessor controlled system — Rank Hovis McDougall		92	Spring 1984
Bread oven heat recovery	*	16	Heat recovery for space heating — Squires & Kintons	16	46	Mar 1982
Heat recovery from other ovens	*	17	Heat recovery for space heating, biscuit ovens — United Biscuits	12	98	June 1982
	*	18	Heat recovery for oven re-use, rusk oven — RHM Ingredient Supplies		9	June 1982
				48	361	
DAIRY						
Heat recovery	*	19	Insulated trucks — Magness & Usher	13	20	June 1982
	*		(Mechanical vapour recompression (MVR) evaporator — Milk Marketing Board — Dairy Crest)	(10)	(90)	
	†		(Heat pipe MVR spray drier — Carbery (IR))			
Heat pumps	*		(Electric heat pump for heat recovery — Midland Counties Dairies)	(6)	(40)	
	†		(Diesel engine heat pump — N.V.AAN En)			
	†		(Reverse osmosis skim milk — Coop De Eendracht)			
	†		(Combined heat and power — Kerry Creameries)			
				13	20	
REMAINING SECTORS	†		(Total energy for frozen food factory — Campbell (N))			
	*		(Steam turbine heat pump — Marfleet)	(17)	(70)	
	†		(Improved dewatering of beet residue — Nordharzer Zucker)			
	†		(Improved dewatering of beet residue — Socode)			
	†		(Waste heat recovery in starch processing — Zetmeelbedruiven De Bijenkorf)			
	†		(Open cycle heat pump on drier — A Tomadini)			
				—	—	
			TOTAL	324	1256	

KEY * Existing project
† EEC project

NB Items and values in brackets are not included in the above totals. They are incorporated in the figures for other technologies elsewhere in the document. EEC demonstrations are excluded.

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Table 8.6 The food processing industries: Replication and energy saving targets for existing projects

	Project	Project profile number	No of companies in target market	Energy savings (A) and required number of replications (B)						Potential equipment suppliers
				Dec 85		June 88		Long term		
				A '000 tce/y	B No	A '000 tce/y	B No	A '000 tce/y	B No	
	BREWING									
1	Keg washing/filling heat recovery — Scottish & Newcastle	13	60 sites	2	10	5.5	45 sites	6	50 sites	Canongate Technology set up by Scottish & Newcastle (host) will exploit. Also Burnett & Rolfe, GKN Sankey and Universal Equipment.
2	Waste heat recovery feasibility study — Bass		78 (75% of sales from 6 companies)	—	—	—	—	—	—	
3	Hot water from recovered heat — Ind Coope	ø		2	3	10	20	15	30	APV spiral coil unit used. Others possible include Alfa-Laval.
	MALTING									
4	Run around coil — Associated British Maltsters	49	40	40	15	75	28	97	36	GEA and HTI units used. Others possible include Corning, Air Frohlich, Thermal Transfer, Custom Coils.
5	Run around coil — Pauls & Sandars	33								
6	Gas engine heat pump — Associated British Maltsters	36		—	—	—	—	—	—	GEA and HTI are suppliers. Other possibles include Sulzer.
7	Barley dust as fuel — Associated British Maltsters	37		—	—	—	—	—	—	
	SPIRIT DISTILLING									
8	Automatic control of stills — Bells	131	100 malt distilleries	6	30	20	100	20	100	Solatron used. Also Honeywell.
9	Thermocompression on condensers — Morrisons	192		6	6	18	18	36	36	Design lead by consulting engineers. Need more active involvement of equipment suppliers.
10	Condenser heat for pot ale evaporation — Bells	85		5	8	15	25	22	50	
11	Reject condenser heat — Morrisons	15		3	2	6	3	11	6	Design lead by consulting engineers.
12	Waste heat for distillation residue evaporation — Bells	190		5	3	23	16	46	32	Need more active involvement of equipment suppliers — Gibson Wells, Stord Bartz & APV used.
13	Use of flash steam in cereal cooking — Grants	61	3	3	1	7	2	10	3	
	FOOD BAKING									
14	Lanham/Tweedy energy efficient system — Family Loaf Bakery	75	100 companies with 66% production from 2 companies	2	3	6	9	20	30	Lanham (US) plant used. Replication plant will be made in UK by Tweedy of Burnley.
15	Baker Perkins microprocessor controlled system — Rank Hovis McDougall	ø								
16	Heat recovery for space heating — Squires and Kintons.	77		1	2	3	5	16	27	Aldridge Air Control, Airaqua units used. Other possibles include Atlas Equipment, Heatsure, Thermsave Engineering, APV, Alfa-Laval.
17	Heat recovery for space heating, biscuit ovens — United Biscuits	76	75 factories with 66% production from 3 companies	2	1	4	3	12	8	
	DAIRY									
19	Insulated trucks — Magness & Usher	16	350 sites	—	—	5	50	13	100	Members of Vehicle Builders & Repairers Association.
			TOTAL	77	84	197.5	324	324	508	Excludes heat pump projects as noted.

ø Project Profile not yet published.

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Section 9 The paper and printing industries

(Mr B C Bateman)

Energy use

The Paper Industry is ranked sixth in the UK for the consumption of energy. It is the second largest private generator of electricity and is placed third in energy intensiveness, only after steel and ceramics. However as an industry it is in decline and, following a peak in output in 1973, there have been some 50 mill closures involving the shutdown of about 150 machines and a reduction in the workforce of 36%.

At the end of 1982 the industry comprised some 53 main companies employing just under 40,000 workers at about 115 mills equipped with some 240 paper machines. These mills are used to produce newsprint, printing and writing papers, corrugated case materials, packaging papers and boards, tissues and specialist papers and board. In 1982 the combined output of these mills totalled some 3.2 million tonnes, about half the UK consumption. The domestic proportion of this consumption is significantly lower than in other countries, notably European, due mainly to two factors. First, the energy intensiveness of the paper making processes and the relatively lower energy costs abroad reduce the ability of the UK mills to compete. Secondly, foreign mills are technically more economic due to their ready access to raw materials through the integration of forestry and the paper making processes.

Faced with these factors the UK industry has invested first of all in methods to improve unit output and product quality and secondly in measures to reduce costs and specific energy consumption. Closure of uneconomic mills and the more efficient use of energy has resulted in a consistent decline in the average specific energy consumption such that, in 1982, it was approximately 21 GJ/tonne, some 15% lower than in 1977. Statistics on energy consumption, which are compiled and published annually by the British Paper and Board Industry Federation (BPBIF) show that in 1982 the industry consumed some 2.65 million tonnes of coal equivalent (Mtce) of primary energy (70 PJ). Of this total, 31% was fuel oil (all kinds); 29% natural gas; 27% coal; 12% purchased electricity and the remainder was waste fuels and other processes, including purchased steam. The proportions are given on a direct calorific equivalent basis and are not, as in the case of purchased electricity, expressed in terms of the calorific value of the energy used to produce it. Correcting for this increases the apparent consumption by about 28% and gives an equivalent electrical consumption of approximately 1 Mtce (27 PJ).

Although it is a large user of energy, the industry tends to use it efficiently since the processes require both heat and power. Combined heat and power (CHP) plants are an important contributor in this respect and can average an efficiency of 70% of the thermal equivalent of the primary fuels used, whereas the efficiency of grid-borne supplies is generally of the order of 30% when the waste heat and steam is rejected to the environment. In 1982 the industry generated some 4 PJ of electricity which was 32% of its total electricity consumption. However the trend in self generation is falling; in 1965 it was 66%. The main reasons for this are the poor investment capability of the industry in a declining market where first priority must be the investment in paper making plant, and continuing uncertainty about future fuel supplies and prices.

The conversion of paper and board, and printing and publishing are closely related to paper production and are necessarily included. Their energy consumptions are each approximately a fifth of that of paper production but with substantially lower specific use concentrations due to the much larger number (in total some 13,000) of companies involved. Oil and gas combined dominate the energy use in these sectors, principally for space heating, with electricity accounting for some 16–18% of the total energy use, mainly for use in motive power and lighting. Solid fuel is a small proportion of the total and is in the range 1–4 per cent.

The scope for improved efficiency

There is considerable potential for energy saving in the paper industry. Information obtained under the Industrial Energy Thrift Scheme (IETS) has indicated that savings of about 13% may be realised. In 1979, when the report was published, this amounted to some 600,000 tce/year (16 PJ/year). However more recent estimates based on information provided by BPBIF suggest that overall savings in excess of 30% should be possible of which about half has been achieved in one way or another. Energy conservation within conversion, printing and publishing could amount to some 10–15% and so add a further potential saving of about 150,000 tce.

At the present time, taking into account work of the Paper Industry Research Association (PIRA), the overall technical potential for further savings in paper production is thought to be about 20% or about 500,000 tce/year; this is based upon the 1982 BPBIF energy consumption survey. Of this, perhaps 300,000 tce/year is recoverable with commercially attractive payback periods.

The most important opportunity for saving energy is in the drying part of the process which uses 70 to 100 per cent of the process heat. Waste heat recovery, humidity control and the greater use of mechanical de-watering would lead to significant savings.

Refining and waste treatment uses between 30 and 60 per cent of the electricity consumed as well as up to 30 per cent of process heat. Smaller but still significant amounts of energy could be saved here.

Good housekeeping measures such as control of ventilation, insulation of drying cylinder end caps and efficient handling of condensate can also give useful savings. However the effect of cylinder insulation is reduced when the drying area is totally enclosed. In this event controlled ventilation and heat recovery is a more cost effective solution.

At present the generation of power is declining and this is against the world trend. However the present cost of

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replacement of old, worn out plant is so great and the payback so long that investment cannot be justified. However, there is still a need to operate individual boilers, groups of boilers and generating plant as efficiently as possible. The use of microprocessor control can make valuable improvements with a short payback period. Advantage can also be taken of various electricity load management options available from area boards. There is a need for further R&D on a number of topics, the main one being the development of humidity and temperature sensors that will operate reliably in the environment of a machine house. Further developments in methods of slushing and cleaning waste paper to reduce energy consumption are also required. New techniques for drying such as radio frequency heating need further development. At present this is an expensive technique only justified for special papers which command a high price, yet energy savings could be significant.

Dry forming of paper could reduce energy demands, but its applications are limited. However, a combination of wet and dry forming has potential and is considered to be worthy of further development.

Significant energy savings could arise from a more detailed understanding of the precise operating characteristics of paper machines. The development of the methodology and subsequent optimisation of machine paper mix may be worth further investigation. In general the industry realises the value of energy conservation and is committed to it as an important requirement for future profitability. The lack of apparent action in recent years has been a consequence of the depressed state of the industry.

Savings in conversion, printing and publishing may be brought about through improvements in ventilation and heating controls; by the reduction in power requirements through inverter control of motors, and through more efficient use of boiler plant and lighting.

Proposed programme and energy saving targets

The proposed programme for the paper industry is detailed in Table 9.1. Seven demonstration projects are in hand costing Government about £600,000 which should stimulate energy savings of nearly 160,000 tce/year worth about £10 million annually in 1982 money terms. To achieve this saving the industry will need to invest substantially, perhaps of the order of £30 million and this can only be stimulated by encouragement and the dissemination of the results of successful projects. In addition, mainly through the efforts of industry itself, there are some six prospective projects which may achieve a further saving of about 80,000 tce/year. A further four more speculative projects are identified for consideration by the industry. Savings here are less easy to quantify but should exceed 100,000 tce/year. The BPBIF and PIRA are both very active in the promotion and encouragement of these projects.

Projects of first priority are those of water removal and drying where the greatest potential for saving exists. Of these, water removal is the most important since it is the most effective way of removing moisture and by doing so diminishes the demand upon the drying sections, the most profligate energy element of the paper production process. The reduced demand then may be realisable by increased production rate (an effective reduction in specific energy consumption) or by direct energy saving. Heat recovery in the drying section, however, is the most attractive commercially and, significantly, these dominate the prospective projects. Next most important are 'housekeeping' measures, especially insulation and ventilation control whereby practically every mill can achieve energy savings at modest cost with short payback. In the case of ventilation control, as stated above, preliminary development work is necessary before a demonstration is possible.

Current status of the programme

The seven firm projects should themselves realise savings of about 16,000 tce/year. There are good prospects that the prospective projects will come to fruition within about one year and, of these, the prospective humidity control project will initially require limited research and development to determine adequate humidity monitors. Once this has been achieved, humidity control can be linked very effectively with other heat recovery projects and with motor control, thus maximising their effect. It is therefore of considerable importance to the attainable energy saving targets. The printing project which is based upon an efficient energy management system coupled with motor control of ventilation has significant potential to the industry but also has much wider application throughout general industrial ventilation processes.

Current replication targets for the seven projects are shown in Table 9.2. These targets are, however, subject to the development of the industry and assume that the investment potential is not only there but is realised. Moreover by the nature of the demands on the industry, paper mills operate continuously and only shut down perhaps once or twice a year for essential maintenance or overhaul. It is, therefore, only at these times that replication can be achieved and therefore promotional activity will, in some cases, achieve replication perhaps 1–2 years after the event.

The 'required' projects are almost entirely speculative and only in some cases is it possible to give estimates of energy savings. Some of these projects are, however, in areas in which the industry is showing, or has earlier shown some interest. Local steam turbines, dry/combined paper production and machine mix methodology are notable in this respect. It is hoped that these will become less speculative.

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Table 9.1 The paper and printing industries: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
IMPROVED DEWATERING	*	1	NIPCO press rebuild — Reed (Aylsford) Ltd	20	240	1984
	*	2	Dewatering through heat recovery — Thames Board Ltd	60	86	
DRYING						
Heat Recovery	*	3	Air/air heat recovery — Tullis Russell	20	22	Ongoing
	+	4	Heat recovery and direct gas firing	20	30	
Ventilation	+	5	Dryer hood humidity control	15	20	
	+	6	Inverter control of ventilation motors	12	20	
Cylinder Improvements	*	7	Insulation — Wiggins Teape	} 10	30	1984
	*	8	Insulation — Gestetner			
	o	9	Direct gas firing	50	30	
Drying Improvements	+	10	Infra-red heating	10	20	
	o	11	Radio-frequency heating	10	20	
STEAM RAISING AND POWER GENERATION	+	12	Steam generation using waste heat	15	20	
	+	13	Pressurised condensate systems	10	20	
	o	14	Local steam turbines	10	10	
	*		(Landfill gas as fuel — Thames Board Ltd)	(60)	(84)	
NEW PROCESSES	o	15	Dry or combined paper production	20	30	
PRINTING	*	16	Energy conservation in printing — Odham's Sun Ltd	40	124	1984
OTHERS	*	17	Waste stock preparation — Thames Board Ltd	10	75	1984
			TOTAL — ACTUAL	160	577	
			— ACTUAL & POTENTIAL	312	797	

KEY * Existing project
+ Prospective project
o Required project

NB Items and values in brackets are not included in the above totals. They are incorporated in the figures for other technologies elsewhere in the document.

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Table 9.2 The paper and printing industries: Replication and energy saving targets for existing projects

	Project	Project profile number	No of companies in target market	Energy savings (A) and required number of replications (B): Dec 85 A '000 tce/y	Dec 85 B No	June 88 A '000 tce/y	June 88 B No	Long term A '000 tce/y	Long term B No	Potential equipment suppliers
1	NIPCO Press rebuild — Reed (Aylsford) Ltd	ø	30	—	—	10	2	20	4	Escher Wyss
2	Dewatering through heat recovery — Thames Board Ltd	ø	115	—	—	30	6	60	12	Haden-Carrier Ross
3	Air/air heat recovery — Tullis Russell	45	60—100	12	6	20	10	20	10	Haden-Carrier Ross
7	Cylinder insulation — Wiggins Teape	114	} 115	2	5	6	15	10	25	Bertram Sciennes, P. and S. Textiles
8	Cylinder insulation — Gestetner	113								
16	Energy conservation in printing — Odham's Sun Ltd	ø	>10,000[1]	4	2	20	10	40	20	Atlantic Instruments/TGI (France)
17	Waste stock preparation — Thames Board Ltd.	ø	≯10	2	1	6	3	10	5	Voith
			TOTAL	20	14	92	46	160	76	

ø Project profile not yet published
[1] Multi-sectoral applications

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Section 10 The textile and laundry industries

(Mr B C Bateman)

Energy use

The textile and laundry industries consume around 4 million tonnes of coal equivalent (Mtce)/year (114 PJ/year), with the largest fuel input being in the form of fuel oil for raising steam.

In the textile manufacturing sector the cost of energy is on average about 10 per cent of the total turnover value, with the production and processing of synthetic fibres accounting for approximately 40 per cent of the total primary energy attributed to the industry i.e. about 1.6 Mtce/year. The processing of a wide variety of textile substrates in fabric and yarn production in the textile finishing sector, consumes approximately 1.0 Mtce/year. The wool and worsted sector is not energy intensive as a whole, but the production and finishing of materials accounts for 15 per cent of the total energy used in the industry (~600,000 tce/year) as individual processes for wet processing and drying have a high energy consumption.

Most enterprises in the textile industry are at present in a depressed state. The main cause of the decline, other than the general trade recession, is attributed to more competitively priced imports from the Far East, Europe and the USA resulting from lower unit labour costs and the cheaper fuel policies adopted by some countries.

The main obstacle to improved energy consumption in the textile industry is the uncertain return on capital from investment in energy saving projects. Many firms operate on a single shift basis owing to staffing problems and increased wage costs for night work. This limits the more efficient use of energy and the rate at which the cost of capital investment can be recovered. In addition the cost of energy relative to the value of the final product is low and energy cost savings are therefore less significant.

In the laundry industry the cleansing of a wide range of articles manufactured from a variety of different textiles consumes around 600,000 tce/year. All laundries are extremely heavy energy users. The conventional washing process is one where large quantities of comparatively high grade energy are discharged to atmosphere or drain and, in addition, flash steam is often vented direct to atmosphere. Consequently, the scope for heat recovery is great.

Efficiency in the laundry industry is heavily dependent on the efficiency of the cleansing process and the thermal and mechanical efficiencies of current drying techniques. However the high energy use allows conservation techniques to play a major role in reducing production costs.

The laundry industry, in common with most other industries, is at present suffering from the recession, with the cleansing of work wear currently falling off due to the decline in manufacturing industry.

The scope for improved efficiency

Recent study has identified the longer term energy conservation potential within textiles to be about 25 per cent. Opportunities for saving energy lie mainly in the wet processing parts of textile preparation and finishing, and in the wool and worsted sectors. From this study it is estimated that a reduction of 40 per cent in the energy consumed in wet processing could be obtained by the application of existing technology; for example by using counterflow in washing, by generally reducing water consumption, by limiting idling losses and installing heat exchangers for recovery of heat from effluents. Opportunities may be categorised as follows as a percentage of the some 3 Mtce/year used in the industry:

Reduced water/energy consumption in wet processes for textile preparation (10 per cent).

Heat recovery from effluent streams (5 per cent).

Improving the efficiency of stentors and dryers (5 per cent).

Improved steam distribution and boiler control (5 per cent).

In the laundry industry, present indications are that it is possible to reduce energy consumption by about 20 per cent using proven technology for the recovery of waste heat from the cleansing and drying processes.

In the longer term, improvements resulting from better machine design and the progressive change to fabrics containing a greater proportion of synthetic fibres, should result in overall energy savings in excess of 30 per cent (180,000 tce/year) of the potential.

The laundry industry as a whole is very conscious of energy costs and is in general very receptive to energy conservation proposals.

Proposed programme and energy saving targets

The programme for proposed demonstrations for the textile and laundry industries is detailed in Table 10.1. This shows a portfolio of 11 existing projects (6 in textiles and 5 in the laundry sector) costing Government £400,000: this should stimulate energy savings of some 90,000 tce/year, worth about £20M annually in present money terms.

Five additional prospective projects are envisaged, 4 of them in the textile sector, with a potential for saving almost 100,000 tce/year. One additional more speculative project on improved efficiency of stentors and dryers is also envisaged in the textile sector.

In the textile industry priority needs to be given to textile preparation and finishing in the wool and worsted and the textile finishing sectors which offer the largest energy saving opportunities. The textile finishing sector and the wool and worsted sector still retain a separate identity within the industry and are served by their own Research Associations.

In the laundry industry the first priority is the recovery of waste heat from the cleansing and drying processes using proven technologies. In the longer term it is necessary to demonstrate improvements resulting from the adoption of new systems with inherent energy savings, such as low temperature washing.

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Current status of the programme

Of the eleven projects operating in the textile and laundry industries, four within the laundry sector are being promoted vigorously. The textile sector contains new and long term projects which have yet to be promoted. The projects at WIRA and the Shirley Institute should yield valuable information on energy conservation measures. Table 10.2 shows the replication targets for the existing projects in the short, medium and long term.

Future plans

Table 10.1 shows the likely development of the programme in the near future. Action in the future has to be focussed on obtaining projects in the production and processing of synthetic fibres, where there is a need for a variety of projects aimed at reducing the energy consumption in the extrusion and adhesive bonding of fibres, and attracting projects for improving the efficiencies of washing and drying of synthetic fibres. As yet these areas have not been explored in detail. The main thrust of the future programme will be to improve awareness of the needs of both the Textile and Laundry industries, and to develop projects for demonstration that reflect the long term futures of those industries.

Table 10.1 The textile and laundry industries: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
TEXTILES	*	1	Radio frequency dyeing of loose stock fibre — Dawson International	12	90	1986
	*	2	Energy efficient dyeing of fabric — James Dewhurst	20	40	1985
	*	3	Improving the performance of heat recovery systems in the wool textile industry — Wool Industries Research Association	18	42	1984
	+	4	Improved dyeing processes in a carpet factory	50	40	
	o	5	Improved efficiency of stentors and dryers	15	30	
	+	6	Heat recovery in wool scouring	10	15	
	*	7	Heat recovery — A F Nichols	Small	12	Ongoing
	+	8	Combined heat and power in the leather industry	15	40	
	+	9	Thermostatic heat recovery	10	25	
	*	10	A study of the potential for energy savings in textile finishing — Shirley Institute	—	62	
	*	11	A study of continuous washing processes to determine potential for energy savings	—	47	
	*		(Small gas engine heat pump for waste heat recovery — Vitatex)	(16)	(38)	
	*		(The concentration and combustion of scouring effluent — Woolcombers)	(5)	(83)	
			TEXTILES TOTAL — ACTUAL	50	293	
			— ACTUAL & POTENTIAL	150	443	
LAUNDRIES	*	12	Heat reclamation in garment finishing — Fenland Laundries	8	11	1983
	*	13	Demonstration of new heat recovery equipment — Regency Laundry	12	17	1985
	*	14	Heat recovery from laundry effluent — Belgrave Laundry	} 8	24	1983
	*	15	Heat recycling system — Fabricare (Glossop)		11	1983
	*	16	Low energy laundry — Wessex Regional Health Authority	12	42	1983
	+	17	Heat recovery through water recycling	10	20	
			LAUNDRIES TOTAL — ACTUAL	40	105	
			— ACTUAL & POTENTIAL	50	125	
			OVERALL TOTAL — ACTUAL	90	398	
			— ACTUAL & POTENTIAL	200	568	

KEY * Existing project
+ Prospective project
o Required project

NB Items and values in brackets are not included in the above totals. They are incorporated in the figures for other technologies elsewhere in the document.

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Table 10.2 The textile and laundry industries: Replication and energy saving targets for existing projects

Project	Project profile number	No of companies in target market	Energy savings (A) and required number of replications (B)						Potential equipment suppliers
			Dec 85		June 88		Long term		
			A '000 tce/y	B No	A '000 tce/y	B No	A '000 tce/y	B No	
TEXTILES									
1 Radio frequency dyeing of loose stock fibre — Dawson International	ø	70	—	—	5	10	12	24	
2 Energy efficient dyeing of fabric — James Dewhurst	ø	300	0.5	1	10	20	20	40	
3 Improving the performance of heat recovery systems in the wool textile industry — WIRA	ø	Numerous	3	Many	10	Many	18	Many	
7 Heat recovery — A F Nichols	6	—	0.03	—	—	—	Small	—	
			3.5		25		50		
LAUNDRIES									
12 Heat recovery in garment finishing — Fenland Laundries	157		—	—	4	50	8	100	
13 Demonstration of new heat recovery equipment — Regency Laundry	ø		0.2	4	1	17	12	200	
14 Heat recovery from laundry effluent — Belgrave Laundry	158	2000	—	—	4	17	8	34	
15 Heat recycling system — Fabricare (Glossop)	160								
16 Low energy laundry — Wessex RHA	159		—	—	4	10	12	30	
			0.2		13		40		
		TOTAL	4		38		90		

ø Project profile not yet published

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Section 11 Heat pumps

(Mr G Newbert)

The technology

Heat pumps are one of the most efficient ways of supplying heat. By replacing boilers and other conventional heating methods in industry and buildings, heat pumps could produce large energy savings. They deliver more energy than they consume by recovering low temperature waste heat or by taking heat from ambient sources and then upgrading this heat to a useful temperature.

The places where heat pumps can be used are technically and economically limited. In practice heat pumps will recover heat from air or liquid streams in the temperature range 10°C to 50°C and use this for heating air or liquid streams in the range of 40°C to 100°C. Advanced systems could extend this range. Because of their high cost, heat pumps will be used where a high annual utilisation is expected and where other simpler and cheaper forms of heat recovery cannot be used.

Best performance is obtained from a heat pump when it operates steadily and continuously under the conditions for which it has been designed. Because of this, the heat flows at a site and their temperatures must be well defined before a heat pump application is any more than superficial. If these are anticipated wrongly then the return from an investment in a heat pump will not be as expected.

Drying and evaporation, heating and cooling and waste heat recovery in continuous processes seem to hold the most promising applications for heat pumps. Swimming pools provide a good example, with about 200 existing installations. The operating conditions and the hours of operation can be estimated accurately and they give a classic application for a heat pump, with low temperature heating, long hours of use and an ample heat source at a temperature not much lower than that needed in the pool hall.

Heat pumps are expensive, complex machines and their economic viability is only marginal at present. Reasons other than energy cost savings are commonly needed to justify a heat pump sale. For example, swimming pools need dehumidification, which the heat pump can provide alongside the energy savings. The main market for heat pumps in future will depend mostly on energy savings and so significant heat pump sales will rely on higher energy prices or lower heat pump costs.

The potential user, newly looking at the possibilities, can select from a range of heat pumps. The two main choices are electrically driven or fossil fuelled systems, each with subgroups. Gas engine and absorption are two sorts of fossil fuelled systems. Different types suit different applications but generally the choice rests on the site economics and practicalities. Experience of the leading types is needed to demonstrate the choice to the potential user.

Potential energy savings

Heat pumps can be used in the three market sectors; industry, non domestic buildings and domestic buildings. Space heating in buildings offers the biggest energy saving potential, but the market will take a long time to emerge. In this area some research and development will be necessary before substantial market sales can be expected. It is in swimming pools and industrial process heating that cost effective heat pump applications will happen in the shorter term. And it is on these two areas that heat pump demonstrations will focus.

In industry, applications for heat pumps are found mainly in companies that are intensive users of warm process water and air. These industries include food, textiles, chemical and paper industries. Of these, the food industry has been the most receptive to demonstration projects. The energy used in the UK for low temperature heating is very large but, recognising the technical and economic limitations of heat pumps, the potential energy savings through demonstration in the two sectors are as follows:

Sector	Potential Saving (tce)
Industry	600,000
Swimming Pools	50,000

Proposed programme and energy saving targets

The heat pump demonstrations aim to establish the technical and economic viability of the range of heat pumps operating in different industrial processes.

The figure below shows in blank matrix form the more obvious industrial processes where heat pumps could have an impact, and the leading heat pump types. Demonstrations are looked for in these more likely applications.

		Industrial Processes			
		Drying	Heating and Cooling	Process Heat Recovery	Space Heating
Electrically driven	Large				
	Small				
Gas engine driven	Large				
	Small				
Other drives					

The purpose of the programme is to demonstrate the main types of heat pump working on the four industrial processes in projects that meet Energy Efficiency Demonstration Scheme (ED) criteria. It is expensive and unnecessary to demonstrate each sort of heat pump on every process, so only some of the boxes in the matrix will be filled. In some cases, replication will be encouraged with one project demonstrating the process which can make use of a heat pump and other projects demonstrating the range of equipment.

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Table 11.1 lists the projects currently supported with the prospects and requirements, making up a complete portfolio of projects. This draws on the requirements and opportunities presented in the matrix and bears in mind the currently supported demonstration projects.

An important part of the demonstration programme is to encourage advanced systems. The demonstration projects to date are examples of established technology adapted to the heat pump market. The lessons from this are still to be learnt but a main point is clear: competitiveness has to be improved, usually in the area of reduced costs which may be achieved by new techniques. Improvements, when they can give a real advantage, will be demonstrated. The improvement must be a significant step rather than a gradual one so that its value can be measured clearly. The demonstration can sensibly be on the same application as earlier projects so that the monitoring can focus on the significant technical differences.

Current status of the programme

Half the projects in the programme are now running and on average these are halfway through. The report on the Louth project is published and reports on six other projects are now being prepared.

Future plans

The shorter term programme will concentrate on three priorities:

a) monitoring reports

b) initiating projects to complement the existing programme, and

c) the promotion of existing projects to encourage replication in the more promising target areas (Table 11.2).

The first priority is to ensure the reports on existing projects are written to a good standard.

Table 11.1 Heat pumps: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
ELECTRIC HEAT PUMPS	*	1	Electric heat pump for heat recovery — Midland Counties Dairies	6	40	
	+	2	Electric heat pump for waste heat recovery (reciprocating comp)	10	30	
GAS ENGINE HEAT PUMPS	*		(Gas engine heat pump in a maltings — Associated British Maltsters (Louth))	—	(177)	
	*	3	Gas engine heat pump in a maltings — Pauls and Sandars Ltd (Grantham)		195	
	*	4	Small gas engine heat pump for waste heat recovery — Vitatex	10	38	
OTHER DRIVES	*	5	Steam turbine driven heat pump — Marfleet	10	70	
	o	6	Absorption heat pump	20	40	
HIGH TEMPERATURE	o	7	High temperature electric heat pump	100	40	
	†		(High temperature gas engine heat pump)			
SPACE HEATING	o	8	Electric heat pump for space heating	100	40	
	o	9	Engine heat pump for space heating		40	
ADVANCED SYSTEMS	+	10	Reversed absorption heat pump	10	50	
	o	11	Brayton cycle heat pump	10	50	
	o	12	Turbo-rankine heat pump	10	50	
HYBRIDS	*	13	Heat pump with power generation — Associated British Maltsters (Wallingford)	Incl. above	176	
STEAM COMPRESSORS	*	14	Mechanical vapour recompression (MVR) evaporator — Milk Marketing Board — Dairy Crest	10	90	
	*	15	Steam turbine driven MVR — Inverhouse Distillers Ltd	40	86	
	o	16	Small packaged MVR evaporator	22	70	
	o	17	Steam compression drying	60	70	
	o	18	Steam compression distillation	22	70	
SWIMMING POOLS	*	19	Gas engine dehumidifier — Rushmoor Borough Council	50	63	Sept 1984
	*	20	Gas engine dehumidifier — Wandsworth Borough Council		53	
	*	21	Gas engine dehumidifier — Ettrick & Lauderdale District Council		39	
			TOTAL	490	1400	

KEY
* Existing project
\+ Prospective project
o Required project
† EEC project

NB Items and values in brackets are not included in the above totals. They are incorporated in the figures for other technologies elsewhere in the document.
EEC demonstrations are excluded.

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Table 11.1 shows the prospective and the required projects that will complete the proposed programme. These will be pursued and those that come forward will be sponsored for ED support.

Swimming pools represent an early market for heat pumps. The Sports Council is planning over 200 new and refurbished pools in the next few years and all of these will need an efficient heating and ventilating system. To encourage the optimum selection of equipment, ED promotion aimed directly at the sector will cover more conventional heating methods as well as both electric and gas engined heat pumps.

Table 11.2 Heat pumps: Replication and energy saving targets for existing projects

	Project	Project profile number	No of companies in target market	Energy savings (A) and required number of replications (B)						Potential equipment suppliers
				Dec 85		June 88		Long term		
				A '000 tce/y	B No	A '000 tce/y	B No	A '000 tce/y	B No	
1	Electric heat pump for heat recovery — Midland Counties Dairies	34	10	—	—	3	6	6	10	NEI, York, APV Hall
3	Gas engine driven heat pump in a maltings — Pauls and Sandars Ltd	65	40	*	*	*	*	*	*	APV Hall
4	Small gas engine heat pump for heat recovery — Vitatex	86	80	—	—	5	10	10	50	AES, Denco, APV Hall
5	Steam turbine driven heat pump — Marfleet Refining Co	70	40	—	—	2	3	10	15	APV Hall
13	Combined heat pump and power generation — Associated British Maltsters	66	40	*	*	*	*	*	*	GEA, APV Hall
14	MVR evaporator — Milk Marketing Board — Dairy Crest	183	60	4	2	4	2	10	7	5 companies of which APV is UK based
15	Steam turbine driven MVR — Inverhouse Distillers Ltd	60	70	5	1	29	2	40	4	
19	Gas engine dehumidifier — Rushmoor Borough Council	100								Denco Air, AES Ltd, York
20	Gas engine dehumidifier — Wandsworth Borough Council	123	100	5	10	10	20	50	100	
21	Gas engine dehumidifier — Ettrick & Lauderdale District Council	ø								
			TOTAL	14	13	53	43	126	186	

ø Project profile not yet published
* See Section 8 — Table 8.6 Project No 6

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Section 12 The brickmaking and refractories industries

(Dr K Fletcher, Mr J Furnival)

Energy use

There are large areas of overlap of technology for these two industries; they are therefore discussed together to avoid repetition.

In 1980 the consumption of conventional primary energy in brickmaking was approximately 750,000 tonnes of coal equivalent (tce)/year (210 PJ/year), which represents 30–40% of production costs. About 50% of UK bricks are still made by the London Brick Company (Fletton Bricks); their process uses relatively low levels of conventional energy (coal) and is rather inflexible (total energy 160,000 tce/year (4.4 PJ/year) with high carbon content clay).

The refractories industry which includes both shaped products, powders and their raw materials, consumes 410,000 tce/year (11.5 PJ/year) which represents ~25% of production costs. This industry has contracted significantly over the past 5 years due to reduced demand in the metals industry and a highly competitive international market.

Overall the brick and refractories sector has shown a 30% reduction in production index over the past 10 years with no significant improvement in overall specific energy consumption. This is because of changes in product towards a broader range of goods, in many cases of better quality, which demand a higher energy content.

The scope for improved efficiency

In brickmaking significant energy savings could arise from some fundamental changes in product type and processes including:

- use of higher carbon clays and carbonaceous additives
- increasing brick perforations (>25%)
- packages of improved process control measures covering materials preparation, drying and firing.

In refractories, major opportunities are associated with process improvements such as high temperature heat recovery and better process control. These areas have been identified on the basis of cost effectiveness — maximum 2½ year payback, leaving aside less attractive options such as low temperature heat recovery.

Proposed programme and energy saving targets

A list of demonstration projects relevant to both sectors is given in Table 12.1. These are drawn from some of the original sector Audit recommendations and are supplemented by additional opportunities more recently identified.

A total energy saving target of 236,000 tce/year is assessed for brickmaking (30%) with 102,000 tce/year in refractories (25%). In total 14 projects or small packages of projects are identified at an estimated cost to the Energy Efficiency Demonstration Scheme (ED) of £546,000.

Current status of the programme

Presently, 8 projects are being funded at a cost to ED of £216,500. Target savings from funded projects amount to 77,500 tce/year against a total identified target of 338,000 tce/year. We are thus over half way through the project initiation stage in these sectors.

The replication markets and energy saving targets of existing projects are shown in Table 12.2. Major areas of replication are seen as improved process control and the increased use of carbonaceous additives in brickmaking.

Increasing building brick perforations (up to 25%) now appears to be acceptable to the industry and some early energy savings have been recognised. Greater than 25% perforations needs, however, further Research and Development (R&D) work prior to uptake by the industry. Increased use of carbonaceous additives is developing only slowly within the brick sector and to date only one project has been funded using carbonaceous shales. Further projects are required using other raw materials and replication is therefore likely to occur only slowly in this area.

Further projects in the area of improved process control — particularly in drying and raw material control — are still required and a significant opportunity for savings by coal firing has been abandoned in brickmaking because of problems with residual ash.

Future plans

The package of projects for the demonstration of improved process control and increased carbonaceous additives in brickmaking needs to be expanded and a further 4–5 projects are still required.

For increased brick perforations (>25%) an R&D project has now been identified.

Although the demonstration at W T Lamb is likely to have a widespread application for heat recovery from corrosive exhausts generally, the programme requires further demonstrations in this general area of heat recovery and utilisation.

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Table 12.1 The brickmaking and refractories industries: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
BRICKMAKING	*	1	Increased brick perforations to 25% — promotion by BRE Digest	20	2.5	June 1983
	*	2	Increased carbonaceous additives — 4 plant demos package — Ibstock Brick Co (to date)	8	31	Sept 1984
	*	3	Coal firing retrofit for tunnel kiln — Ibstock Brick Co *(project unsuccessful)*	–	46	
	†		(New coal firing system — Lohlein)			
	†		(Dry pressing of clay tiles — Italsvenska)			
	*	4	Heat recovery from clamps and small intermittent kilns — W T Lamb	2.5	16	April 1984
REFRACTORIES	o	5	Heat recovery from rotary kiln exhausts	15	35	
	o	6	Improved insulation material for rotary and tunnel kilns (1500°C)	35	25	
	*	7	Heat recovery from afterburnt exhaust gases — tar bonded refractories (feasibility study only) — Union Carbide	7	17	Feasibility report May 1984
RELEVANT TO BRICK-MAKING & REFRACTORIES	*	8	Improved process control package — feasibility study by W S Atkins and BCRA		29	Jan 1983
	*	9	Automatic control of tunnel kiln temps — Steetley Refractories	40	24	June 1984
	*	10	Automatic control of tunnel kiln firing — J & A Jackson		51	Jan 1985
	o	11	Demonstrations based on 8 (2 projects)		150	
	o	12	Gas heat pump in dryers	40	40	
	o	13	Exhaust heat recovery from tunnel kilns — new recuperator system(s) demonstration	45	30	
	o	14	Demonstrations based on 2 (3 demos)	125	50	
			TOTAL Brickmaking Refractories	236 102	546	

KEY * Existing project
o Required project
† EEC project

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Table 12.2 The brickmaking and refractories industries: Replication and energy saving targets for existing projects

	Project	Project profile number	No of companies in target market	Energy savings (A) and required number of replications (B): Dec 85 A '000 tce/y	Dec 85 B No	June 88 A '000 tce/y	June 88 B No	Long term A '000 tce/y	Long term B No	Potential equipment suppliers
	BRICKMAKING									
1	Increased brick perforations to 25% (Production of Digest) — Building Research Establishment	ø	25	6.0	12	10.0	20	20	40	
2	Increased carbonaceous additives — Ibstock Brick	81		1.0	2	4.0	8	8.0	16 20.0	Oxygen suppliers: Air Products; British Oxygen
	HEAT RECOVERY									
4	Heat recovery from clamps — W T Lamb	98	10	0.3	1	1.0	3	2.5	8	Glass heat exchanger: Corning Glass
7	Heat recovery from afterburnt exhaust gases — tar bonded refractories (feasibility study only) — Union Carbide	—		—	—	1.4	2	7.0	10	Waste heat boiler: Danks; Robey; NEI; Beltran Cooper
	PROCESS CONTROL									
8	Improved process control (feasibility study) — W S Atkins	—								
9	Automatic control of tunnel kiln temperatures — Steetley Refractories	99	30	1.5	3	10.0	10	40.0	25	Control suppliers: Negretti Zambra; Servelec; Westinghouse; etc
10	Automatic control of tunnel kiln firing — J & A Jackson	181								
			TOTAL	8.8	18	26.4	43	77.5	99	

ø Project profile not yet published

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Section 13 The pottery industry

(Dr K Fletcher)

Energy use

This industry encompasses a wide range of processes and products and in each case energy costs assume a varying degree of importance against labour costs, plant efficiency, etc. For this reason, attitudes towards energy conservation differ considerably throughout the sector. The main fuels used are natural gas and electricity: the estimated distribution of energy consumption within the industry is given below together with total sales value.

Because of the higher percentage fuel costs, sanitaryware and tile manufacturers have tended to dominate the sector in energy saving investment, whilst tableware is more concerned with productivity.

The whole industry has recently undergone a large rationalisation programme which has led to various potteries being closed. The index of production has fallen by over 35% in the last five years and although this has led to a slight increase in specific energy consumption recently, overall there has been a better than 20% improvement over the past ten years.

The scope for improved efficiency

This industry has not been apathetic to energy saving and most of the opportunities identified in the past in the Audit and Industrial Energy Thrift Scheme (IETS) studies have now been investigated. Much of the work has been carried out by the British Ceramic Research Association funded by the Requirements Boards of the Department of Trade and Industry and results have tended to highlight difficulties with projects and existing equipment. The Energy Efficiency Demonstration Scheme (ED) offers the opportunity to demonstrate solutions to these problems.

Opportunities for energy saving fall into two categories:

- plant and efficiency improvements — including waste heat recovery, improved drying techniques and improved kiln design and firing control in tunnel kilns. These together provide a target energy saving of 76,000 tce/year.
- fundamental process changes — including direct firing of sanitaryware and a range of opportunities for fast and once firing, which offers the largest single opportunity for energy saving in the tile and tableware sectors. The total technological potential saving for fast and once firing is estimated at 145,000 tce/year. However, a realistic total target for open flame firing of sanitaryware, together with fast and once firing of tiles and tableware is estimated at 107,000 tce/year.

Proposed programme and energy saving targets

A list of demonstration projects within the above two categories is given in Table 13.2. These are drawn from some of the original Audit recommendations but also include those additional process changes indicated above. A total target energy saving of 183,000 tce/year (30%) is identified, requiring ten demonstration projects or small packages of projects at a total cost to ED of £590,000. Priority areas are seen as fast and once firing together with process improvements in kiln firing and ware drying.

Current status of the programme

At present seven projects are being funded with an additional fibre insulation project being handled under the high temperature insulation programme. The cost to ED of these seven projects is £320,000 and their target energy saving is 133,000 tce/year. We are therefore well over half way through the programme of project initiation in these areas.

Table 13.1 Sales values and energy distribution between sectors (1980)

	Sales Value (£M)	Total Primary Energy		Percentage Energy Cost Against Sales	Total Primary Firing Energy	
		'000 tce/y*	PJ		'000 tce/y*	PJ
Tableware						
- china	120.5	85	2.4	6.2	54	1.5
- earthenware	169.4	186	5.2	8.0	117	3.2
Sanitaryware	78.7	149	4.2	14.2	86	2.4
Electrical	~ 45.0	64	1.8	11.0	30	0.8
Tiles	~102.0	166	4.6	12.0	120	3.5
Industry totals	515.6	650	18.2	9.5	407 (325.10³ tce/yr – Tunnels) (82.10³ tce/yr – Intermittents)	11.4

*tce: tonnes of coal equivalent.

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The replication markets and energy saving targets for existing projects are shown in Table 13.3. It is anticipated that, whereas the package of heat recovery projects is likely to be only slowly adopted, the fast firing and sanitaryware projects should prove of more immediate interest.

Future plans

Projects still required include improved optimisation and control of both dryers and kilns, and the development of fast and once firing of glost tableware and, particularly, flatware. The present package of fast firing projects will be promoted during 1984 in accordance with the sector's requests for early information and it is anticipated that further demonstration projects in the area will emerge during 1984/85. Heat recovery will be given a lower priority subject to prevailing attitudes within the Industry.

Table 13.2 The pottery industry: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
PLANT AND EFFICIENCY IMPROVEMENTS	*	1	Heat recovery from muffle tunnel kiln exhausts — Twyfords Bathrooms	3	14	Apr 1983
	*	2	Heat recovery from intermittent kiln exhausts — A G Hackney	3	19	June 1984
	*	3	High temperature combustion air system — English Ironstone	20	24	Jan 1985
	o	4	Improved kiln design and firing control in tunnel kilns	25	60	
	o	5	Improved dryer recirculation and optimisation	25	110	
	*		(Ceramic fibre insulation of intermittent kilns — J E Heath)	—	(16)	
PROCESS IMPROVEMENTS						
Sanitaryware direct firing	*	6	Conversion of muffle kiln to direct firing — Twyfords Bathrooms	7	50	Mar 1984
Fast and once firing package	*	7	Demonstration of integrated fast firing system for tiles — A G Tiles	50	123	Dec 1984
	*	8	Fast firing of holloware — James Sadler	50 (items 8–12)	35	Mar 1984
	*	9	Fast once firing of holloware tableware — Broadhursts		55	July 1985
	o	10–12	2–3 further demos of UK developed kilns for glazed ware and flatware fast and once firing		100	
			TOTAL	183	590	

KEY * Existing project
o Required project

NB Items and values in brackets are not included in the above totals. They are incorporated in the figures for other technologies elsewhere in the document.

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Table 13.3 The pottery industry: Replication and energy saving targets for existing projects

	Project	Project profile number	No of companies in target market	Energy savings (A) and required number of replications (B): Dec 85		June 88		Long term		Potential equipment suppliers
				A '000 tce/y	B No	A '000 tce/y	B No	A '000 tce/y	B No	
	HEAT RECOVERY PACKAGE									
1	Heat recovery rom muffle tunnel kiln exhausts — Twyfords Bathrooms	19	~20	—	—	3.0	10	3.0	10	Encomech supplier of ceramic tube unit but other recuperators possible for this area
2	Heat recovery from intermittent kiln exhausts — A G Hackney	97	~40	0.2	1	0.7	3	3.0	14	Lamanco, IMI, Encomech, Custom Coils
3	High temperature combustion air system — English Ironstone	ø	~60	—	—	4.0	20	20.0	100	System developed by Lisland Ltd
	SANITARYWARE									
6	Conversion of muffle kiln to direct firing — Twyfords Bathrooms	83	5	2.4	3	3.5	4	7.0	8	Drayton Kiln Co — other UK kiln suppliers also possible
	FAST AND ONCE FIRING PACKAGE — Requires additional projects in support of complete package									
7	Fast firing of tiles — A G Tiles	180	4 (tiles only)	—	—	8.0	2	50.0	12	Strong competition from overseas kiln suppliers. UK companies supplied kilns in projects 8 and 9 — Fire Power (8); Drayton Kiln Co (9). Others: Bricesco; Welman; J Birks
8	Fast firing of holloware — J Sadler	139	40 potential tableware companies for fast firing technology	5.0	10	30.0	60	50.0	100	
9	Fast once firing of holloware table ware — Broadhursts	169								
			TOTAL	7.6	14	49.2	99	133.0	244	

ø Project profile not yet published

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Section 14 The glass industry

(Dr K Fletcher)

Energy use

The United Kingdom glass industry produces about 3 million tonnes of glass products per year and can be divided into manufacturers of containers, flat glass, domestic ware, glass fibre and other items, including scientific ware, tubing and industrial glassware. The industry used 1.8 million tonnes of coal equivalent (Mtce) of primary energy (50.4 PJ) in 1980 to produce 2.9 million tonnes of glass, and energy consumption in the industry dropped by 18% from 1973 to 1980 while the 1980 production level was 5.5% below that in 1973. Data for production and fuel consumption for 1973 and 1980 are given in Table 14.1.

The principal energy consuming processes in glass making are melting, conditioning and annealing, with melting accounting for over 80% of total energy use in the flat glass and container sectors and 68% in domestic glass. In glass fibre manufacture, the forming or fibrising process is the most energy intensive at around 40%.

The glass industry, in common with most other industries, has suffered from the recession. Furthermore, the industry as a whole is experiencing loss of market to non-glass products, particularly to plastic containers. The greatest threat is from polyethylene terephthalate (PET), which has captured 15 per cent of the market for non-returnable containers for soft drinks, compared with 12 per cent for glass containers. An additional threat to the UK market is from foreign competition. Imports rose from 218,000 tonnes in 1973 to 383,000 tonnes in 1980 while exports remained more or less constant at about 330,000 tonnes.

The scope for improved efficiency

The major opportunities for energy savings are in waste heat recovery and improvements to the melting process for the industry as a whole, and in the forming process for the glass fibre industry.

Large energy savings from the recovery of waste heat are somewhat speculative, particularly those associated with regenerative burners and waste heat boilers. The most promising area for development would seem to be in improved regenerator design, particularly secondary regenerators.

Improvements to the melting process largely centre around the use of all-electric or mixed melters. At the moment it seems unlikely that all-electric melters larger than about 100 tonnes/day would be energy efficient on a primary energy basis. For smaller sizes the case is not so clear as small fossil fuelled furances are less efficient than the larger ones. The crystal sector in particular could benefit from all-electric melting.

Another area which could produce major energy savings is to reduce the amount of glass which has to be returned for re-melting (currently about 15% for containers). A 7% reduction in rejects corresponds to an energy saving of about 6,500 tce/year, for the container sector. It should be noted that one of the claimed benefits of electric melting is to reduce the amount of rejected ware. Other methods for reducing the reject rate need to be identified, and it is felt at this stage that research and development may be necessary to identify why rejects occur and how the rate can be reduced.

Many of the energy saving projects are in direct competition, for instance, if regenerative burners were adopted there would be no need for projects on regenerator improvements or on waste heat boilers.

Proposed programme and energy saving targets

A list of demonstration projects seen as relevant to the industry at the present time is given in Table 14.2. They are divided into two distinct sets of opportunities:

- Process efficiency improvements including mixed and all-electric melting and electric heating of forehearths. The

Table 14.1 The glass industry: Production and fuel consumption

Production	1973 '000 tonnes		1980 '000 tonnes	
Flat glass	654		494	
Containers	2,040		1,996	
Other glass	370		408	
Total	3,064		2,898	
Fuel consumption	'000 tce	PJ	'000 tce	PJ
Electricity*	460	12.8	420	11.8
Oil	1,330	37.4	780	21.9
Gas	400	11.2	600	16.7
Total	2,190	61.4	1,800	50.4
Specific energy consumption GJ*/tonne	20.0		17.4	

*Primary energy

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Table 14.2 The glass industry: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
MELTING	*	1	Mixed melter, small size (20 t/day), white soda glass — Glass Bulbs	20	140	Jan 1986
	o	2	All electric melter, crystal glass	16	200	
	*	3	Improved combustion control — Redfearn National Glass	13	18	July 1985
CONDITIONING	*	4	Immersed electrode forehearth for white flint glass — Redfearn National Glass — *project failed*	14	28	
	*	5	Immersed electrode forehearth for green glass — Rockware Glass		25	June 1980
FORMING AND ANNEALING						
	o	6	Glass fibre spinner improvements	12	20	
				75	431	
WASTE HEAT RECOVERY						
Working end	*	7	Ceramic recuperators in working end — Beatson Clark — *project failed*	2	5	
	*	8	Recuperative burners in working end — Beatson Clark			May 1984
	*	9	Heat recovery from space above working end — Rockware Glass	16	16	Apr 1984
Annealing lehr	*	10	Heat recovery from hot gas discharge from annealing lehr — Pilkington Bros		66	Sept 1984
Hot containers	*	11	Heat recovery for space heating — Rockware Glass		2	May 1984
Melting	o	12	Heat recovery via waste heat boiler or power generation from melting	140	100	
	†		(Utilisation of waste heat from glass container furnace — Clerresheim Glas)			
	o	13	Regenerative burners		300	
	o	14	Regenerator improvements/secondary regenerators		200	
				158	689	
			TOTAL	233	1120	

KEY * Existing project
o Required project
† EEC project

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total energy saving target from these areas is 75,000 tce/year.

- Utilisation of waste heat from a range of process areas. Total energy saving target 158,000 tce/year.

A total target energy saving for the 14 existing and required projects is 233,000 tce/year at a total Energy Efficiency Demonstration Scheme (ED) funding cost of £1.12M.

Current status of the programme

There are, at present, nine projects funded at a total cost to Government of £300,000. Target energy savings from these projects amount to 65,000 tce/year.

Two projects in the current package have failed; the electric forehearth on white flint glass at Redfearn National and the ceramic recuperator in the furnace working-end at Beatson Clark. Working-end heat recovery problems occurred at Beatson Clark when the ceramic recuperator failed and the scheme has now been replaced by a self-recuperative burner system.

The replication markets and energy saving targets of existing successful projects are shown in Table 14.3. It is anticipated that, whereas the electric melting and forehearth conditioning is likely to develop only slowly with a need for further project support, heat recovery opportunities will prove of more immediate interest to the sector.

Future plans

The package of heat recovery projects is due for completion during 1984 and it is planned to promote results during the later part of the year. Electric melting is a longer term proposition and a package of demonstrations still needs to be developed in this area. Preliminary results from the improved combustion control project should be available by the end of 1984, and these will be promoted.

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Table 14.3 The glass industry: Replication and energy saving targets for existing projects

Project	Project profile number	No of companies in target market	Energy savings (A) and required number of replications (B)						Potential equipment suppliers
			Dec 85		June 88		Long term		
			A '000 tce/y	B No	A '000 tce/y	B No	A '000 tce/y	B No	
1 Mixed melter, small size (20 t/day) — Glass Bulbs	ø	10	—	—	2.0	1	20	10	KTG Ltd, Sorg (UK) Ltd, C Rhett Inc, Electroglass Ltd
3 Improved combustion control — Redfearn National Glass	189	8	—	—	4.0	8	13	26	Research Inc — other process control companies also possible
4 Electric forehearth for white flint glass — Redfearn National Glass 5 Electric forehearth on green glass — Rockware Glass	46	8	2.0	6	5.0	15	14	42	As (1)
8 Recuperative burners in working end — Beatson Clark	141	8	—	—	0.5	2	2	7	Hotwork Ltd
9 Heat recovery from working end — Rockware Glass 10 Heat recovery from annealing lehr — Pilkington Bros 11 Heat recovery from hot containers for space heating — Rockware Glass	42 43 48	12	—	—	5.4	18	16	55	Range of possible suppliers: Industrial Cooling Ltd, Aldridge Air Control Ltd, etc
		TOTAL	2.0	6	16.9	44	65	140	

ø Project profile not yet published

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Section 15 The cement and construction materials industries

(Dr K Fletcher, Mr J Furnival)

Energy use

The energy use in these sectors is dominated by cement manufacture: in 1980 primary energy consumption was 3.3M tonnes of coal equivalent (tce)/year (92 PJ/year) compared with an estimated 5.4 Mtce/year (151 PJ/year) for the whole sector.

In cement manufacture almost 90% of the energy is used in kilns to produce the cement clinker and this is now supplied totally as coal. The remaining energy is in the form of electric power for milling and grinding both raw materials and the cement clinker. It is estimated that 40% of production costs is currently accounted for by energy.

Other construction products include a wide range of items ranging from roadstone, gravel and sand through to ready mixed concrete and concrete products e.g. blocks. These products use a variety of fuels generally for drying or curing. The energy used is disaggregated and forms a lower percentage of production costs. To date these sectors have not been regarded as a priority area for energy saving although a study is being undertaken to establish better the patterns of energy consumption and the opportunities for improved energy use.

Overall, these sectors have shown a reduced output over the past 10 years — the cement index of production has reduced by over 25% since 1974. Specific energy consumption has, however, improved significantly (20% improvement over the past 10 years).

The scope for improved efficiency

Most energy savings in cement production have been due to substantial plant changes or closures of obsolete kilns. Smaller scale savings as achieved with retrofit heat recovery schemes or minor process trimming have not been given major priority to date because of other more pressing opportunities. For this reason, there is still some way to go in maximising the use of waste heat and/or minimising the use of premium fuel through waste burning and better process tuning. The major opportunity remains, however, the conversion of wet process works to dry or semi-wet routes with a target saving of 200,000 tce/year for semi-wet conversions, and this is still seen as the priority area. Other opportunities fall into two main categories:

- waste heat utilisation (target 150,000 tce/year)
- process upgrading including better kiln insulation, improved combustion control and grinding techniques and waste as a fuel (total target 145,000 tce/year)

In the other construction materials sector, opportunities are less well defined at present, although 3 distinct areas have emerged to date:

- improvements to road resurfacing techniques (target 100,000 tce/year)
- improved drying and heating techniques for aggregates (target 20,000 tce/year)
- process improvements in concrete block manufacture (target 17,000 tce/year)

In addition two disparate areas, lightweight aggregates and energy saving in mixing/suspension of minerals, have been identified as warranting support.

Proposed programme and energy saving targets

A list of demonstration projects for these sectors is given in Table 15.1. For cement, many of the projects are drawn from the original Audit recommendation, although waste burning and improved process control have been added. Other Audit recommendations have, however, been dismissed, particularly those associated with blended cements (where a Research and Development programme is likely to be more relevant), or where energy savings are likely to be small or restricted (i.e. kiln dust return, increased sulphate levels and slurry additives).

In construction materials, the list is made up from on-going projects, areas already identified as offering savings opportunities and a limited number of current prospective projects.

A total energy saving target of 495,000 tce/year (15%) is estimated for cement manufacture with a further 137,000 tce/year (7%) for other construction materials. In total 17 projects or small packages of projects are identified at an estimated cost to the ED Scheme of £2.37M. Priority areas across the sectors are seen as the semi-wet conversion and refuse burning projects in cement, and road resurfacing process improvements.

Current status of the programme

At present 10 projects are being funded at a cost of £1.963M and target energy savings from these projects amount to 384,000 tce/year against a total identified target saving of 664,000 tce/year for the whole sector programme. We are, therefore, over half way through the programme of project initiation by number of projects.

The replication markets and energy saving targets of existing projects are shown in Table 15.2. The priority wet to semi-wet conversion area in cement making is likely to lead to a high replication within the next five years. Other areas in cement are, however, more speculative and significant uptake appears unlikely in the short term though, if successful, the kiln combustion control project at Blue Circle should offer high replication opportunities by 1988. In the construction materials sector, it seems likely that coal-fired drying systems will be adopted widely in the medium term in the roadstone industry. Concrete block production, lightweight aggregate manufacture and controlled mixing of suspensions are unlikely to make any impact until around 1986 when these projects will have been completed and monitored fully.

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Future plans

In cement, results from semi-wet conversion are presently being disseminated and it is further intended to provide interim data on on-going projects such as refuse burning and improved kiln control during 1984. There remains the need however for demonstration projects on heat recovery, and projects are being sought in this area.

There is still a need to clarify programme requirements in the construction materials sector. It is planned to initiate an energy survey of this sector which will include the extraction and processing of materials and the manufacture of products. The completion date of this survey is anticipated to be August 1984.

Table 15.1 The cement, minerals and construction materials industries: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
CEMENT						
Wet to drier processes	*	1	Semi-wet conversion — Rugby Cement	200	1030	Aug 1983
	*	2	Improved filtration techniques — Steetley Refractories		150	June 1984
Waste heat utilisation	o	3	Over fence heat supply demonstration	150	100	
	o	4	Process power generation		200	
	†		(Use of waste heat from a cement kiln — Felice Rusconi)			
	†		(Utilisation of radiant heat from a cement kiln — INTERATOM)			
Process up-grading	*	5	Improved insulating refractories — Tunnel Cement	25	59	Aug 1985
	*	6	Improved kiln combustion control — Blue Circle Cement	40	64	Aug 1985
	*	7	Waste as a fuel — Blue Circle Cement	60	228	Sept 1984
	o	8	Improved grinding techniques	20	25	
	†		(Cement rotary cooler — Creusot-Loire)			
	†		(Clinker roasting plant — Lurgi/Creusot-Loire)			
	†		(Clinker production from industrial wastes — Ecopiemonte)			
	†		(Refuse burning in cement kiln — Dyckerhoff)			
	†		(More efficient fuel burning system in lime shaft kiln — Sauerlandische Kalkindustrie)			
			TOTAL	495	1856	
CONSTRUCTION MATERIALS						
Road resurfacing	*	9	Energy savings in road resurfacing — Associated Asphalt (Project failed to show energy savings)	100	9	
	+	10	Recycling of road surface materials		15	
Drying	*	11	Pulverised coal fired drying of coke — Standard Pulverised Fuel	20	26	June 1984
	+	12	Coal fired drying of aggregates		20	
	o	13	Improved drying of aggregates		30	
Block manufacture (process improvements)	*	14	Concrete block manufacture — energy savings — Hemelite Ltd	7	78	Sept 1984
	o	15	Heat recovery from *aerated* concrete blocks	10	15	
	†		(Use of coal fluidised bed ash to produce calcium silicate bricks — De Hazelaar)			
			TOTAL	137	193	
MISCELLANEOUS	*	16	Manufacture of lightweight aggregate from colliery waste — Thermal Conversions (UK) Ltd	20	296	Dec 1985
	*	17	Energy saving in mixing/suspensions — HMR Group Ltd	12	23	Mar 1985
			TOTAL	32	319	

KEY * Existing project
+ Prospective project
o Required project
† EEC project

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Table 15.2 The cement, minerals and construction materials industries: Replication and energy saving targets for existing projects

	Project	Project profile number	No of companies in target market	Energy savings (A) and required number of replications (B)						Potential equipment suppliers
				Dec 85		June 88		Long term		
				A '000 tce/y	B No	A '000 tce/y	B No	A '000 tce/y	B No	
	CEMENT SECTOR									
1	Semi-wet conversion — Rubgy Cement	20	7	77	5	140	7	200	10	Kiln Conversion: F L Smidth, Polysius, Humbolt; Filter Press: Manor Engineering, Steetley Engineering
2	Improved filtration techniques — Steetley Refractories	129								
5	Improved insulating refractories — Tunnel Cement	130	7	—	—	12	8	25	16	Refractories supplied by G R Stein
6	Improved kiln combustion control — Blue Circle	185	7	—	—	20	10	40	20	Blue Circle systems development
7	Waste as a fuel — Blue Circle	106	7	—	—	30	2	60	4	Main contractors — Peabody Holmes
				77	5	202	27	325	50	
	CONSTRUCTION MATERIALS									
11	Pulverised coal fired drying of coke — Standard Pulverised Fuel	133	50 approx	1.0	10	11	100	20	200	Thermo Murg, Hamworthy, Stordy
14	Concrete block manufacture — Hemelite Ltd	166	60	0.6	1	3.5	6	7	12	Plant: Blockmaking Equipment Suppliers; Handling System: Conwork (Sole suppliers)
16	Manufacture of lightweight aggregate from colliery waste — Thermal Conversions	150	9	—	—	10	2	20	4	Process developer — Sherwen Engineering
17	Energy saving in mixing/ suspensions — HMR Group	177	40	1.0	1	6	7	12	15	Process control equipment suppliers
				2.6	12	30.5	115	59	231	
			TOTAL	79.6	17	232.5	142	384	281	

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Section 16 The chemicals and oil refining industries

(Mr A C Mercer)

Energy use

The primary energy used by the chemicals industry in 1981 amounted to approximately 14 million tonnes of coal equivalent (Mtce) (380 PJ); in oil refining the energy used was 9.7 Mtce (260 PJ). Together these sectors account for 27% of UK industrial energy consumption. Within the chemicals sector, process energy amounts to over 90% of the total and the figure is even higher in oil refining. Overall the energy cost within the chemicals industry in 1981 amounted to around 7% of a sales value of £15,200M.

Very broadly the chemicals industry can be divided into 3 types of production process:

- The production of bulk organic, inorganic and petrochemicals in large, highly integrated, continuously operating plant. Process heating and distillation are the predominant energy using operations.
- The production of speciality chemicals, dyestuffs and pharmaceuticals, commonly requiring a relatively low temperature reaction stage followed by separation and purification processes. Here energy use in drying represents a more significant percentage, and semi-continuous and batch processes are often used.
- The production of paints, plastics, cosmetics, adhesives and photographic materials usually on a small scale, with a significant energy use in space heating.

To date it has proved difficult to identify a role for the Energy Efficiency Demonstration Scheme (ED) within the chemicals and oil refining industries because of the limited replication potential in specific sectors of the industry. For this reason progress has been slow. A recent study has attempted to assess opportunities using a generic technological approach across sub-sectors. This divided the total energy use into a number of unit operations such as process heating, drying, compressed air production etc. and showed that process heating is the largest energy consuming operation accounting for 38%, with evaporation and distillation a further 30%. Space heating, drying and a number of other operations each account for approximately 5%.

During the 1970s the energy consumption per unit output within the chemical industry was reduced by about 20%. In general, this was achieved by the adoption of improved energy management and good-housekeeping measures, as well as the replacement of older less energy-efficient plant. The equivalent savings in the oil industry are more difficult to assess due to changes in throughput and operating practices, but the reduction in energy use per unit consumption is probably around 20–25%.

The scope for improved efficiency

The effect of recession, with a resulting world-wide over-capacity, reduced profitability and cash-flow in certain areas to crisis levels. Although there are now signs of an improvement, there is still little or no scope for constructing new energy-efficient plant. Energy conservation however is seen as an attractive means of improving profitability but the industry generally demands payback periods of 18–24 months or less.

Various approaches to improved energy efficiency are possible:

- Improvement in the efficiency of those generic technologies relevant to the industry. These include heat recovery schemes, operational changes and equipment improvements.
- An important opportunity is in the application of process integration techniques. This thermodynamic analysis of energy flows has led to the design of highly cost effective energy saving projects within ICI and a handful of overseas companies. This type of approach could have a significant impact on energy consumption, but there are problems of introducing the technique, particularly in convincing management of the potential benefits.
- Scope for significant energy savings by the use of new energy efficient processes. Large scale plant is expensive but the introduction of new improved processing *stages* may be cost effective.
- On the large energy consuming sites there is a diminishing scope for further 'good housekeeping' measures. However in the smaller subsectors such as dyestuffs and pigments good housekeeping still provides conservation opportunities.
- Increased use of microprocessor-based control systems represents a conservation opportunity. In addition the advent of comprehensive energy monitoring systems may have a significant impact.

Proposed programme and energy saving targets

An outline strategy for energy efficiency demonstration projects in the chemicals and oil refining sectors is given in Table 16.1. The programme and energy saving targets are based upon the results of the recent energy use study. As this study still requires a further breakdown of energy use in the more important operations and better identification of opportunities for energy saving projects, the programme itself can only be regarded as speculative.

The programme has been split into 4 areas:

- *Generic technologies.* Various areas have already been identified as potentials for demonstration projects, but further work is required fully to identify energy conservation measures which could be applied.

  A provisional total of 20 projects is proposed; at present there are 4 existing projects with 9 further

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opportunities identified. The target saving is 424,000 tce/year at a Government funding of over £0.9M.

- *Process integration.* At present funding is available for feasibility studies which should identify cost effective energy saving measures. Further funding of actual hardware demonstrations is warranted to improve confidence in the process integration approach. In the introduction of process integration, 5 projects are proposed costing £425,000 to fund, with an energy saving target of 260,000 tce/year.
- *Novel heat recovery systems.* This area relates to the improvement of the efficiency of existing processes by some form of heat recovery and does not relate to any particular generic technology. The proposed programme of 5 projects has a target energy saving of 95,000 tce/year at a cost to Government of £205,000.
- *Process developments.* Demonstration of new energy efficient processes through funding new plant is expensive and unlikely to achieve large replication. However development of new processing steps which could be retrofitted to existing plants is under way. A programme of 5 projects is proposed in this area at a cost of £290,000 and a target energy saving of 90,000 tce/year.

To summarise, the proposed programme involves a total of 35 projects with an energy saving target of 869,000 tce/year (worth around £65M/year) at a cost to ED of £1.9M.

Current status of the programme

To date there are 10 projects within the industry. The replication markets and energy saving targets for these projects are given in Table 16.2. The overall target energy saving is 285,000 tce/year from Government funding of £531,000. We are therefore approximately 25% of the way through the project programme initiation stage.

Table 16.2 shows that within the generic technologies area there is a package of existing projects on heat recovery from spray dryers. The largest and most important areas of process heating, distillation and evaporation still require the majority of the projects to be initiated although one project on distillation technology already exists at ICI.

The other significant package is on process integration, where the target is 260,000 tce/year. There are two existing projects, one at ICI and a further one at Clayton Aniline. The ICI distillation project can also, however, be incorporated into this package since the project design is based upon the process integration approach.

In the area of heat recovery there are three current projects offering a replication target of 55,000 tce/year. With two of these projects there has already been considerable replication. Berk Spencer Acids — 28,000 tce/year and Tioxide UK — 3,200 tce/year. The monitoring of the Croda project has failed to demonstrate energy savings.

Future plans

The impact so far of the ED Scheme in the chemicals/oil refining sectors has been limited. In part this is due to problems of identifying sufficient replication potential. However the generic approach of breaking the industry into unit operations should enable the identification of further suitable projects. A major aim is to complete the energy breakdown study and to use that information to detail demonstration project requirements.

For existing projects, the package of improvements for spray dryers will be completed in late 1984 and promotion of the results will be carried out during early 1985. The heat recovery package is still being developed, although promotion of the completed Berk Spencer Acids project has already taken place. It is intended to promote individual projects as they are completed in this area although, in the longer term, a package for promotion covering broader aspects of heat recovery in chemicals/oil refining is planned. The process integration package needs to be incorporated into the promotion of the process integration feasibility studies which is discussed in a separate plan.

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Table 16.1 The chemicals and oil refining industries: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
GENERIC TECHNOLOGIES						
Space heating	*		(Energy Management System — Reckitt & Colman)	(60)	(88)	
	o	1	Solvent contaminated atmosphere	12	50	
Process heating	*	(22)	(Catalytic reformer — Imperial Chemicals Industries PLC)	(100)	(133)	
	o	2	Energy storage — Dyestuffs	20	30	
	o	3–5	Other developments	50	150	
Distillation	*	6	Use of waste heat — Imperial Chemicals Industries PLC	60	97	June 1985
	o	7	Technological improvements	100	100	
	o	8	Mechanical Vapour Recompression		50	
	o	9	Other developments		100	
Evaporation	o	10	Technical development	50	80	
	†		(Vapour compression in alcohol production — Construzioni Industriali)			
	†		(Waste heat utilisation — Akzo Zout Chemie)			
Drying	*	11	Heat recovery spray dryer — ABM Chemicals	10	18	Jan 1985
	*	12	Heat recovery spray dryer — Clayton Aniline		22	
	*	13	Heat recovery spray dryer — British Industrial Plastics		14	
	+	14	Heat recovery band dryer	12	20	
	o	15	Steam recompression	20	80	
	o	16	Improved control	20	30	
	o	17	Other developments	20	40	
Others	o	18	Multi-level refrigeration	50	100	
	o	19–20	Other developments in eg compressed air, pumping, mixing and grinding			
				424	981	
PROCESS INTEGRATION	*	21	Inert gas generation — Clayton Aniline	50	52	Complete
	*	(6)	(Organics plant — Imperial Chemicals Industries Plc)	(60)	(97)	
	*	22	Petrochemical site — Imperial Chemicals Industries Plc	100	133	Jan 1985
	o	23	Oil refinery	50	100	
	o	24	Bulk inorganic	30	70	
	o	25	Batch, speciality chemical	30	70	
				260	425	
HEAT RECOVERY SYSTEMS	*	26	Waste heat recovery in H_2SO_4 plant — Berk Spencer Acids	35	29	Complete
	*	27	Waste heat recovery from heavily contaminated vapour — Tioxide UK	20	77	June 1985
	*	28	Heat recovery from flue gas — Croda Chemicals (project failed to demonstrate savings)	—	19	June 1984
	o	29–30	Other developments	40	80	
				95	205	
PROCESS DEVELOPMENTS	*	31	Solvent recycle — Control Data	10	70	
	o	32	Other waste product recovery	20	50	
	o	33	Integrated operation within dyestuffs	20	70	
	o	34–35	Other developments	40	100	
	†		(Urea recycle — Montedisin SpA)			
	†		(Ammonia nitrate process — UCB SA)			
	†		(Ammonia process — Fertimont SpA)			
	†		(Production of dense soda ash — Akzo Zout Chemie)			
	†		(Production of anhydrous alcohol — Buckan Wallher AG)			
				90	290	
			TOTAL	869	1901	

KEY * Existing project
\+ Prospective project
o Required project
† EEC project

NB Items and values in brackets are not included in the above totals. They are incorporated in the figures for other technologies elsewhere in the document. EEC demonstrations are excluded.

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Table 16.2 The chemicals and oil refining industries: Replication and energy saving targets for existing projects

	Project	Project profile number	No of companies in target market	Energy savings (A) and required number of replications (B): Dec 85 A '000 tce/y	Dec 85 B No	June 88 A '000 tce/y	June 88 B No	Long term A '000 tce/y	Long term B No	Potential equipment suppliers
	GENERIC TECHNOLOGIES									
6	Distillation — Imperial Chemicals Industries PLC	187		0	0	20	3	60	10	
11	Het recovery spray dryer — ABM Chemicals Ltd	108	20 (11–13)	1 (11–13)	10 (11–13)	10 (11–13)	70 (11–13)	10 (11–13)	70 (11–13)	Corning Process Systems Isoterix Numerous heat recovery equipment suppliers (11–13)
12	Heat recovery spray dryer — Clayton Aniline	78								
13	Heat recovery spray dryer — British Industrial Plastics	71								
	PROCESS INTEGRATION									
21	Inert gas generation — Clayton Aniline	2	1500	15	30	27	60	50	120	
22	Petrochemical plant — Imperial Chemicals Industries PLC	ø		0	0	50	3	100	6	
	HEAT RECOVERY SCHEMES									
26	Waste heat recovery — Berk Spencer Acids	1	10	27	7	35	8	35	8	APV Co Ltd + numerous heat exchanger suppliers (26–27)
27	Heat recovery from heavily contaminated vapour — Tioxide	174	20	5	2	12	4	20	8	
28	Heat recovery from flue gas — Croda Chemicals	72	Large	Failed to demonstrate savings						Numerous additives. E Green + others — economiser
	PROCESS DEVELOPMENTS									
31	Solvent recycle — Control Data	137	Large	2	2	5	5	10	10	BOC developed system
			TOTAL	50	51	159	153	285	232	

ø Project profile not yet published

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Section 17 Industrial process control

(Dr K Fletcher, Mr A C Mercer)

Background

The Energy Efficiency Demonstration Scheme (ED) may have a limited role to play in the area of industrial process control for two reasons:

- In many cases energy efficiency is not necessarily the main reason for installing process control and energy savings are therefore often small.
- Industrial process control is intimately involved with the details of the actual process and direct replication potential is therefore often limited. In addition, process secrecy can inhibit companies from considering demonstration projects.

Nevertheless, a number of projects in this area are currently being funded under ED, although most of them are strongly sector orientated and for this reason are considered under separate sector strategies. In general, process control is well developed in larger sectors such as chemicals and iron and steel. In smaller industries such as ceramics and some food areas, it is less developed and demonstrations are likely to have a significant impact in generating interest, with resulting energy savings.

In addition, there is also a range of projects which are considered as relevant across sectors. These include boiler controls, the development of new control and management information systems for energy use and sensor developments: these are discussed in this programme strategy.

The scope for improved efficiency

This technology has been dealt with on a sector basis to date and the scope for efficiency improvements has therefore been considered mainly within these separate sectors. For example in the heavy clay industry it has been estimated that a target energy saving of 40,000 tonnes of coal equivalent (tce) per year might be stimulated by supporting the use of improved process control, whereas in iron and steel, process control is already well developed and demonstrations are less appropriate. In the water industry, target energy savings of 140,000 tce/year are estimated and these have been included in this programme strategy, because no separate priority allocation has been made to this sector. In total, it is estimated that target energy savings of greater than 240,000 tce/year are available from sector specific demonstration projects.

In addition to sector projects, three further areas for demonstration have been identified to date:

- *Boiler control* — the national energy saving potential from the application of advanced boiler controls is substantial at ~350,000 tce/year, especially in the medium sized boiler (8–80 Million Btu) area where existing investment in controls is low compared with the value of fuel consumed (45% of the total UK boiler capacity is made up of medium sized boilers, and their annual fuel consumption is ~60 Mtce/year).
- *General combustion control* — These projects are managed under individual industrial sectors and often form only a part of a much broader improved combustion scheme eg self-recuperative burner developments in the metals industry. There are at present, however, four projects that are specifically combustion control developments — in the heavy clay and glass industries and cement making. These together offer target savings of 93,000 tce/year.
- *Cold storage and freezer plant control* — This type of plant is common to many industries and improved energy efficiency by retrofitting advanced control systems is therefore appropriate for inclusion in the ED Scheme. Reduction in costs can be achieved by scheduling for required loads and in modulating compressor temperatures and pressures. It is estimated that an energy saving target of at least 20,000 tce/year is possible, although this particular area requires further investigation.

Proposed programme and energy saving targets

A list of demonstration projects presently regarded as relevant to the development of this technology is given in Table 17.1: the programme is split into those areas discussed in the previous section. Sector projects (other than the water industry) are not included in the totals, since they have been included in sector targets and expenditures elsewhere. It is clear that presently only a small number of projects (~10, including two in the water industry) are regarded as relevant outside specific sector requirements, although investigations to date have been limited and the programme is therefore only provisional.

Energy saving targets of 228,000 tce/year have been identified *within sectors* at an ED funding cost of £245,000. This programme estimates further targets of 660,000 tce/year at a cost of £429,000.

Current status of the programme

Of the 10 projects identified for support only three are presently being supported, two in the boiler control area and one in the water industry. The two boiler projects offer, however, significant energy saving targets (200,000 tce/year). In the project areas specific to particular sectors, the programme is more developed and in most cases promotional activities have already been defined (see relevant sections).

Table 17.2 identifies the replication markets and energy saving targets of the existing three projects. It is anticipated that in the industrial boiler area, replication will develop quickly, whereas in small heating boilers, take-up will be less dramatic. This area is a difficult one clearly to establish energy savings, and further projects involving alternative sensing and control techniques are likely to be required. In the water industry, promotion of the sewage aeration project has already taken place and replication is likely to develop steadily over the next four years.

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Table 17.1 Industrial process control: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
BOILER CONTROL	*	1	Optimum efficiency control on medium size dual fired boiler — Dalgety Spillers	200	8	Feb 1982
	*	2	O_2 trim control on a gas fired boiler — University of Sussex		13	Aug 1984
	o	3–4	Air fuel ratio control and CO trim on coal and gas/oil fired boiler	150	100	
				350	121	
COMBUSTION CONTROL	*		(Automatic control of tunnel kiln temperatures — Steetley Refractories)	(40)	(24)	June 1984
	*		(Automatic control of tunnel kiln firing — J & A Jackson)		(51)	Jan 1985
	*		(Improved combustion control — Redfearn National Glass	(13)	(18)	July 1985
	*		(Improved kiln combustion control — Blue Circle)	(40)	(64)	Aug 1985
	o	5–6	Sensor and control strategy improvements	>150	100	
				150	100	
SECTOR SPECIFIC (Major examples)	*	7	Control of sewage aeration — Severn-Trent Water Authority	40	134	June 1983
	+	8	Optimisation of water pumping	100	34	
	*		(Improved control of whisky distilling — Bell & Sons)	(20)	(37)	
	*		(Study of improved process control for the heavy clay industry — W S Atkins and B Ceram RA)	(40)	(29)	Jan 1983
	*		(Self recuperative burner control on a pre-heating furnace — Dudley Port)	(75)	(22)	May 1982
				140	168	
FREEZER PLANT CONTROL	o	9–10	Scheduling and compressor temperature and pressure modulation	>20	40	
			TOTAL	660	429	

KEY
* * Existing project
* \+ Prospective project
* o Required project

NB Items and values in brackets are not included in the above totals. They are incorporated in the figures for other technologies elsewhere in the document.

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Table 17.2 Industrial process control: Replication and energy saving targets for existing projects

	Project	Project profile number	No of companies in target market	Energy savings (A) and required number of replications (B)						Potential equipment suppliers
				Dec 85		June 88		Long term		
				A '000 tce/y	B No	A '000 tce/y	B No	A '000 tce/y	B No	
	BOILER CONTROL									
1	Optimum efficiency control on medium size dual fired boiler — Dalgety Spillers	26	40,000	43	1,000	120	3,000	200	5,000	ETC Ltd, Westinghouse, Telegan Ltd
2	O_2 trim control on a gas fired boiler — University of Sussex	165								
	WATER INDUSTRY									
7	Control of sewage aeration — Severn-Trent Water Authority	153	15	8	20	20	50	40	100	Hawker Siddeley
			TOTAL	51	1,020	140	3,050	240	5,100	

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Section 18 Industrial combined heat and power

(Dr R W Clayton)

Energy use

In 1982 the use of electricity by UK industry amounted to 90 TWh (1TWh = 1×10^9) kWh). About 12.0 TWh of this industrial electricity was generated at the point of use — 7.6 TWh in combined heat and power (CHP) plants. The total industrial consumption of electricity produced on power-only plants in 1981 thus amounted to about 82 TWh. This corresponds to a primary fuel consumption of around 37 Mtce[1]/year (980 PJ/year). In the main, existing CHP plants are situated on continuously operating sites in the energy intensive industries. The electricity produced by companies operating within the chemicals, iron and steel, oil-refining, and paper and board industries amounted to almost 90% of the total power produced on industrial CHP plants. In addition there is a considerable, but as yet unquantified, capacity for direct drive CHP. In this instance the mechanical power produced is used directly to drive compressors etc.

Over the years the cost ratio of purchased electricity to fossil fuel has steadily declined. As a result the 'newer' industries have often decided that investment in CHP plant is not cost effective while ageing CHP plants in more mature industries have often not been replaced. Furthermore the heat/power ratios of most existing systems are now out of balance with the sites' energy requirements. This has arisen from the progressive introduction of processes and products which require less energy in the form of heat thus lowering the heat to power ratio. These factors have resulted in a steady decline in the proportion of industrial electricity produced in CHP plants; between 1955 and 1982 the proportion fell from 14% to 8%. There are three ways in which it might be possible to halt or reverse this trend:

(a) To demonstrate cost-effective retrofit projects to 'existing users' which provide the means for more closely matching CHP heat and power output with the site requirements.

(b) To demonstrate cost-effective investment in CHP plants by 'new users'.

(c) To demonstrate improvements in technology which would extend the scope for and improve the economic viability of CHP.

The scope for investment in CHP plant

The *technical* potential for saving national primary energy by the greater use of CHP plant is very large. In practice, technical problems are not the major barriers to investment in CHP plant. An 'economic' energy saving potential which takes into account the real barriers is hard to establish but it may be around 1–1.5 Mtce/year — worth perhaps £60 — 90 M/year. The major barriers to the expansion of industrial CHP capacity are listed below:

- *Payback.* The payback periods of CHP systems are often considered to be lengthy when compared with other investment opportunities. An estimate of CHP payback involves assumptions concerning the relative increases in costs of various sources of energy over periods of several years and hence it is often treated with a certain amount of scepticism. The capital and installation costs may be high and these factors can lead to the view that investment in CHP plant is a high-risk venture from the financial point of view. Especially in the present economic climate, high-risk projects are unlikely to receive funding. This aspect is a major barrier to the installation of new CHP systems, but it is less of a deterrent to investment in retrofit projects where payback periods are often shorter.
- *Confidence.* Potential new users will not, in general, employ staff with technical or operational experience of CHP systems. Even when successful operation of a particular technology has been adequately demonstrated in other industrial sectors, the new users will often lack technical and operational expertise and hence confidence. Since failure or ineffective operation of a large centralised CHP plant has an immediate and profound effect on the factory or site operations, this lack of confidence may lead managers to consider the installation of even a 'conventional' CHP system to be a high-risk technical venture for their company. This problem applies in particular to potential new users in industries with no experience of CHP systems but even where their competitors are established operators this lack of confidence can still be a stumbling block for individual companies.
- *Institutional Barriers.* There are several institutional barriers which have been cited as reasons for lack of investment in CHP plant. These include: gas supply contracts and tariffs, electricity supply and buy-back charges and the regulations concerning connection to the grid. The Energy Act (1983) has done much to clarify or remove certain institutional barriers. This Act places an obligation on the Electricity Supply Industry to supply a private generator, to purchase surplus electricity and to permit the private generator to use the transmission system. It also enables private utility companies to sell power in competition with the public supply system. New standby and buy-back tariffs have been published by the Area Boards. These must reflect the true costs and benefits to the Electrical Supply Industry.

  Some of the remaining barriers may be perceived rather than real but even if they do not have a direct effect on the economics of CHP installations they can lead to extra problems and uncertainties. These features are not present with other investment opportunities which are normally competing for a share of a limited capital budget.
- *Technology.* There is much existing equipment which has been proven in certain industrial sectors. The lack of suitable technology is thus not, in general, the major barrier which inhibits investment in CHP projects by new users. There are, however, certain areas where

[1]Million tonnes of coal equivalent

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the demonstration of 'fringe' improvements or extensions to existing technology could encourage further investment particularly in smaller scale CHP systems. In the retrofit area, the lack of proven equipment can be a more significant barrier to investment and here the demonstration of new technology and/or ideas has a role to play. At the present time it is not considered appropriate to demonstrate, via the Energy Efficiency Demonstration Scheme (ED), new technologies which are still in the development stage.

Proposed programme and energy saving targets

Any strategy aimed at encouraging the broader and more efficient use of industrial CHP should address itself to the four major barriers to investment outlined above. It should also seek to demonstrate, and thereby publicise, the opportunities opened up by the recent Energy Act. There are three areas which this strategy will cover: existing users, new users, and new technology. Each area is discussed separately below:

- *Existing Users.* The major barrier to investment in retrofit projects is a lack of confidence in the areas and/or technology that will be used to integrate the CHP system more closely to the production plant. Further work is required to identify the economic energy saving potential within the industrial sub-sectors where CHP plant is commonplace. Once suitable areas and technologies have been identified then government-funded demonstration projects will be used to encourage further investment in this area.

  About 6–8 retrofit projects may be required to stimulate the more complete integration of existing CHP systems with the site heat/power demands. Likely projects are listed in Table 18.1.

  The total Government cost of this aspect of the programme will be of the order of £1 – 1.5M. Further work is required in order to define a realistic energy saving target but it is thought to be around 500,000 tce/year (13 PJ/year).

- *New Users.* The main barriers encountered by industries without existing CHP facilities are payback and confidence. Further work is planned to identify more clearly industrial sub-sectors where the installation of CHP plant could make a significant contribution to reducing energy consumption and operating costs. In addition to technical considerations such as sizing, heat to power ratio and variability of heat and power demand, this study is under way to assess the economic case for CHP installations and relate this to the investment criteria applied within the individual sub-sectors.

  Having identified suitable industries, the confidence problem will be tackled by funding a limited number of demonstrations within these areas. Some of these projects will also be used to publicise the opportunities now available as a result of the Energy Act 1983. In particular, these include the use of a private utility company to operate a CHP plant on behalf of the host company and the use of the national grid to sell electricity to a third party. It is envisaged that 6–7 projects will be required as indicated in Table 18.1. The cost to Government of this part of the programme could be £2.5 – 3M; an energy saving target of 500,000 tce/year (13 PJ/year) may not be unreasonable.

- *New Technology.* About 6–8 projects may be required in order to demonstrate technological improvements and advances. To obtain the greatest impact at reasonable cost, due consideration will be given to the potential market for each development and projects will be selected accordingly. Possible projects are again identified in Table 18.1. The total Government cost of this part of the programme is likely to be £1 – 1.5M. Again further work is required to define an energy saving target but it may be around 300,000 tce/year (8 PJ/year).

  It is envisaged that some 20–22 projects will be required adequately to demonstrate the opportunities in CHP to existing users, to new users and in new technology. If they were funded individually the total Government cost would amount to £5 – 6M. The replication target is thought to be 1–1.5 Mtce/year (25–40 PJ/year) worth some £60 – 90 M/year.

Current status of the programme

To date there has been little progress in developing a programme of projects for this area. In part this has reflected the steadily declining output of industrial CHP plant and uncertainties regarding the UK economy in general. The publication of the Energy Act (1983) has, however, stimulated interest in CHP within UK industry and early indications are that this will increase the rate of progress of this CHP programme.

Future plans

During 1984, a survey of existing CHP operators will be carried out in parallel with a study of the economic scope for investment in new CHP capacity. This work will enable a more precise definition of the CHP programme with regard to the requirements for projects, Government cost and energy saving targets. Given the lengthy timescales involved in CHP investment, project promotion and dissemination of results will not begin for several years.

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Table 18.1 Industrial combined heat and power: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
RETROFITS TO EXISTING PLANT	*	1	Gas turbine exhaust to process furnace — Conoco	120	180	Dec 1983
	+	2	Gas turbine or diesel combined cycle	100	300	
	o	3	Redesign of boiler preheat train	20	50	
	+	4	Retrofit direct drive steam turbine	30	60	
	o	5				
	o	6	Yet to be defined	230	500	
	o	7				
	†		(Retrofit to existing boiler system — Pirelli)			
	†		(Turbo expander on blast furnace — Thyssen)			
				500	1090	
NEW USERS	+	8	Utility company — single user	60	492	
	o	9	Utility company — several users	50	500	
	o	10	Renting grid to transfer power	30	500	
	+	11	Gas turbine in paper mill	80	429	
	o	12				
	o	13	Yet to be defined	280	1000	
	o	14				
	†		(Combined heat and power in a dairy — Kerry Co-op Creameries)			
				500	2921	
NEW TECHNOLOGY	*	15	Fluidised bed coal boiler — Stevensons Dyers (technical problems)	—	250	
	+	16	Boost-fired diesel	50	300	
	o	17	Small spark ignition engine	10	50	
	+	18	Gas turbine — direct use of exhaust gas	80	493	
	o	19	Radial flow turbine	50	70	
	o	20				
			Yet to be defined	110	250	
	o	21				
	†		(Dual fuel diesel — SAVIEM)			
	†		(GT driving air compressor — Soc. Mecanique Automobile de l'Est			
	†		(Fluidised bed boiler — SA Metallurgic Noboken — Overpelt NV)			
	†		(Organic rankin cycle — Salzgitter A G)			
	†		(Fluid bed combustion — National Coal Board)			
	†		(Coal/oil afterburning on GT — Ruston Gas Turbines)			
				300	1413	
			TOTAL	1300	5424	

KEY * Existing project
+ Prospective project
o Required project
† EEC project

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Section 19 Waste as fuel

(Dr A Brown)

The technology

Assessments have indicated that combustible waste material equivalent to 25 million tonnes of coal (Mtce)/year (675 PJ/year) is generated in the UK, of which 5 Mtce/year (135 PJ/year) could be used economically in the short term (2 Mtce/year from industrial waste, 1.5 Mtce/year from domestic waste and 1.5 Mtce/year from agriculture and timber waste), to save coal, gas and oil in industry. In addition, wet wastes could yield up to 1 Mtce/year (27 PJ/year) as methane gas by anaerobic digestion, saving mostly gas and oil.

Despite this potential, wastes are only replacing around 500,000 tce/year at the moment, mostly via gas produced from sewage digestion and by the use of dry wood wastes in furniture factories. One main opportunity for exploiting wastes in industry is to use them at their point of production, so saving on both fuel and disposal costs. Alternatively the wastes can be prepared and transferred to users, replacing oil or gas and competing with coal as an alternative and cheaper fuel. Systems for using the wastes effectively are now becoming available, but the rate of investment in the technology is restricted, principally because

- both potential users and equipment suppliers have little experience of using waste as fuel and projects are seen as technically and economically risky;
- although waste burning projects offer a good rate of return on investment, the capital costs are high compared with conventionally fuelled systems;
- use of waste as fuel may require organisational changes or collaboration between fuel user and supplier.

Demonstration projects will be an effective way of convincing investors that using waste can be an economic and low risk way of saving energy.

Proposed programme and energy saving targets

Table 19.1 sets out the proposed programme of demonstration projects. This programme covers the range of waste types, scales of operation, technical options and types of user. The long term savings are expected to amount to 1.4 Mtce/year from combustion of wastes and a further 317,000 tce/year from anaerobic digestion. The complete programme will include a total of 9 digestion projects and around 50 combustion projects (2 being included in industry sector plans).

The programme of demonstrations is closely integrated with work on waste funded by the Department of Energy under the Biofuels Programme. Liaison with the work of the Department of the Environment and the Department of Trade and Industry on waste is maintained by an informal Working Group. Advantage is also taken of opportunities for EEC funding.

Current status of the programme

So far 20 demonstration projects are under way, at an anticipated cost to Government of £3.1M. These projects should in themselves save 90,000 tce/year and they have a long term replication target of over 800,000 tce/year. Table 19.2 sets out the replication targets for the projects.

Although none of the projects is yet complete, results are beginning to flow. These suggest that the equipment employed is capable of operating close to design performance and that the projects have avoided the serious technical difficulties that plagued earlier waste-as-fuel projects. The monitoring has shown that there is scope for improving the matching of waste availability, system capacity and heat demand. With adequate attention to presentation at the promotion stage, the projects should stimulate significant up-take of the technology. Indeed, although these projects have not yet been strongly promoted, as monitoring data is only now becoming available, several cases of replication have been reported.

During the coming year projects will start to mature, and a priority task in the near future will be the development of the detailed promotional strategy. The first stage will be to publicise the technology widely via an *Energy Management** supplement and an EEO film†. The market research effort now needs to be built up so as to identify potential replicators and allow a concentrated promotional campaign, particularly of the priority packages of projects on general industrial waste.

Future plans

A review of this part of the programme is under way. When this has been carried out, the portfolio of projects required in the market sectors will be completed. This is expected to take the total number of projects to around 60 (see Table 19.1). The overall programme is likely to cost Government about £6M with an energy saving target around 1.7 Mtce/year.

Domestic Waste. Three projects covering the use of coarsely prepared domestic waste are now under way and no further such projects are necessary. A project covering the production of refined refuse derived fuel (rdf) is included in the programme, together with a set of demonstrations of the use of these fuels in a range of combustion systems. These will build on the combustion trials currently under way in the Biofuels Programme.

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*Produced monthly by the Energy Efficiency Office of the Department of Energy. Available free from Room 1395, Thames House South, Millbank, London SW1P 4QJ.

†*Waste as a Fuel,* Managing Energy films series. Available for purchase or on free loan from CFL Vision, Chalfont Grove, Gerrards Cross, Bucks, SL9 8TN.

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General Industrial Waste. A package of projects in this sector demonstrating the principal technical options is now nearly complete. Large scale projects at Ford and British Airways are in progress together with 5 smaller scale projects. Further prospects involving the use of a fluidised bed combustor, and the use of pelletized industrial waste, are being worked up to complete the package. Once results from these projects become available a review of the need for further projects will be initiated so as to ensure that the principal market sectors are covered. Further market research is needed to build up information on the companies making up the replication target for this area.

Specialised Industrial Waste. Wastes of this type are generated in well defined industrial sectors, making it easier to concentrate promotional effort, particularly as part of overall packages for these industries.

Consultants are being used to assess the need for further projects in this area and this has led to prospects involving paper-making sludge and printing waste, and will highlight the need for further projects in other sectors — provision for these is made in the plan.

Agricultural and Timber Waste. It has proved difficult to establish a significant programme of demonstration projects in this area, with a number of projects failing to go ahead despite grant offers. The plans have been revised to concentrate on the key projects likely to stimulate early savings. In this area the organisation of projects is an important feature to be demonstrated.

Wet Wastes. Wet organic wastes can be anaerobically digested to produce methane. Systems are now commercially available for the digestion of dilute industrial effluents and the project at South Caernarvon Creameries covers this type of application. Development work on the more concentrated and therefore difficult agricultural wastes (eg pig and cattle wastes) is in progress and the plan includes provision for demonstration of the technology when it is ready. The other promising area is the production and use of methane generated spontaneously in landfill sites. At Thames Board the first of 3 user projects is now in progress. The plan also allows for demonstrations of gas abstraction both from existing landfill sites and from green-field sites, where there is considerable potential for increasing gas production by managing the filling operation.

Table 19.1 Waste as fuel: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
DOMESTIC WASTE						
Refined refuse derived fuel	*	1	Refuse derived fuel production plant — Merseyside		708	
	*	2	Refuse derived fuel use in fluidised bed boilers — Associated Heat Services	340	215	June 1986
	†		Refuse derived fuel use — Newcastle C.C.			
	o	3—6	Refuse derived fuel use		300	
Coarse refuse derived fuel	*	7	IMI system — Courtaulds	60	192	Late 1984
	*		(Waste as fuel in cement kiln — Blue Circle)	(60)	(228)	
	†*	8	Fluidised bed — East Lancs Paper Mill	100	322	June 1986
	†		(Refuse and sewage disposal — ESMIL (NL))			
	†		(Refuse fired district heating — MODENA (I))			
				500	1737	
INDUSTRIAL WASTE — GENERAL						
Large scale	*	9	Incineration of factory waste — Ford	30	475	
	†*	10	Incineration of airport waste — British Airways		250	
Medium/small scale	*	11	Starved air system — Freemans		47	
	*	12	Excess air system — British Aerospace		51	Late 1984
	*	13	Modified coal fired boiler — Thorn		55	
	*	14	Waste fired shell boiler — Schofields	200	55	
	+	15	Production and use of pelletised industrial waste		120	
	o	16	Fluidised bed system		110	
	o	17—21	5 complementary projects		300	
	*	22	Off-site waste use	40	219	
	o	23	Off-site waste use	80	100	
				350	1782	

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Table 19.1 Waste as fuel: Proposed programme (Continued)

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
INDUSTRIAL WASTE — SPECIALISED	*		(Barley dust as fuel — Associated British Maltsters)	(—)	(30)	
	*	24	Wool scourings — Woolcombers	5	83	
	†		(Acid tars — Tenneco)			
	*	25	Tyres — Colway	15	64	Late 1985
	+	26	Printing waste	15	90	
	+	27	Paper sludge	15	85	
	o	28	Chemical waste	30	80	
	o	29—34	Other wastes	50	250	
	*		Consultancy — White, Young Prentice-Royle	—	60	
				130	712	
AGRICULTURAL AND TIMBER RESIDUES						
Straw	*	35	Feasibility study — Pauls & Sandars		5	
	o	36	Industrial boiler — process/space heat	30	105	
	*	37	Furnace for chalk drying — Needham Chalks	30	73	Late 1985
	†		(Community heating project — Svendborg (DK))			
	+	38	Straw briquetting plant	20	62	
Wood on-site	*	39	Timber drying — Western Softwood	12	46	Late 1984
	*	40	Wood waste baling — Silentnight	20	45	Late 1984
Wood off-site	o	41	Combined heat and power	60	320	
	o	42	Glasshouse space heating	20	48	
	o	43	Institutional/commercial space heating	10	22	
	+	44	Domestic sector — wood briquetting plant	32	82	
Chicken litter	+	45	Large scale space/process heat	40	110	
	+	46	Small scale space heat	40	35	
Peat	*	47	Crop drying — Vitagrass	40	20	
	o	48	Industrial boiler — process/space heat	100	130	
Others	o	49	Mushroom compost — space heating	12	85	
	†		(Buildings sector — community heating project — Skive Egnens Energiforsyning (DK))			
	*		Consultancy — Biotechnical Processes		20	
				466	1208	
WET WASTES						
Landfill gas	o	50—51	Existing sites — gas abstraction	120	200	Late 1985
	o	52	Greenfield site — gas abstraction		110	
	*	53	Gas use — Thames Board		84	
	o	54—55	Use of landfill gas		150	
Industrial waste	*	56	South Caernarvon Creameries	7	122	Late 1985
Agricultural waste						
— Pig waste	o	57	On-farm digesters	70	50	
— Cattle waste	o	58	On-farm digesters	120	80	
				317	796	
			TOTAL	1778	6116	

KEY * Existing project
+ Prospective project
o Required
† EEC project

NB Items and values in brackets are not included in the above totals. They are incorporated in the figures for other technologies elsewhere in the document. EEC demonstrations are excluded.

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Table 19.2 Waste as fuel: Replication and energy saving targets for existing projects

	Project	Project profile number	No of companies in target market	Energy savings (A) and required number of replications (B): Dec 85 A '000 tce/y	Dec 85 B No	June 88 A '000 tce/y	June 88 B No	Long Term A '000 tce/y	Long Term B No	Potential equipment suppliers No.
	DOMESTIC WASTE									
1	Refuse derived fuel production plant — Merseyside	ø								
2	Refuse derived fuel use in fluidised bed boilers — Associated Heat Services	ø	13,000	50	3	120	8	240	16	
7	IMI system — Courtaulds	52	45	20	2	40	4	60	6	1
8	Fluidised bed — East Lancs Paper Mill	ø	1000	—	—	30	3	100	10	3
	INDUSTRIAL WASTE									
9	Incineration of factory waste — Ford	82	25	5	1	15	3	30	6	4
10	Incineration of airport waste — British Airways	ø								
11	Starved air system — Freemans	23								
12	Excess air system — British Aerospace	74	1000+ commercial sites	7	15	35	45	100	150	10
13	Modified coal fired boiler — Thorn	96								
14	Waste fired shell boiler — Schofields	144								
22	Off-site waste use	ø		—	—	20	5	40	10	
24	Wool scourings — Woolcombers	ø		—	—	3	3	5	5	
25	Tyres — Colway	143	10	2	2	5	3	15	10	5
	AGRICULTURAL AND TIMBER RESIDUES									
37	Furnace for chalk drying — Needham Chalks	ø	?500	—	—	12	6	30	15	3
39	Timber drying — Western Softwood	128	200	3	4	6	8	12	16	3
40	Wood waste baling — Silentnight	155	610	3	3	10	12	20	20	5
47	Crop drying — Vitagrass	10		10	4	30	12	40	16	1
	WET WASTES									
53	Gas use — Thames Board	153	50	20	2	95	8	120	15	5
56	South Caernarvon Creameries	122	250	1	2	3	6	7	30	7
			TOTAL	121	38	424	126	819	325	

ø Project profile not yet published

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Section 20 Electronic energy management systems for non-domestic buildings

(Mr L D Ward)

The technology

Electronic comprehensive energy management (e.m.) technology first became established in the United Kingdom in the early 1970s through the use of large scale building automation systems in large industrial, commercial and public buildings. These early systems were mainly of foreign manufacture (particularly American), expensive to purchase (£100,000 +) and difficult to use without skilled, trained manpower.

Within the last five years, exploitation of low-cost microprocessor technology, particularly by UK firms, has enabled the technology to be extended well down the building size range. In addition, advances in communications technology have provided the means to create e.m. networks with small-to-medium sized buildings remotely monitored and controlled from a central station via two-way automatic telephone links to local intelligent outstations. This concept is particularly attractive to owners of large numbers of buildings (e.g. local and health authorities, retail chain stores, etc). In addition, it enables sophisticated e.m. techniques to be provided as a bureau service to a number of different customers.

Furthermore, availability of microprocessor technology has stimulated considerable advances in systems dedicated to control of individual building services such as air conditioning and lighting.

Happily, the e.m. equipment supply situation is very promising with many (about 20) small, aggressive and motivated UK firms, eager to exploit the technology and markets. Some of these are handicapped by a lack of buildings experience but many have exploited the benefits of the Energy Efficiency Demonstration Scheme. Export markets, however, remain largely untapped and foreign firms still tend to dominate the upper end of the market.

The scope for improved efficiency

Typical energy savings achievable by improved e.m. techniques are in the range 10–20%. The technological potential exists, therefore, for reducing the present consumption of 67 million tonnes coal equivalent (Mtce) primary energy per year in non-domestic buildings by 10 Mtce/year. In reality, economic and other factors will limit uptake in the foreseeable future to around 20% of the total market, giving a likely total economic potential of about 2 Mtce/year.

Proposed programme and energy saving targets

The present strategy for comprehensive e.m. technology is to concentrate on the small-medium sized building sectors, leaving larger buildings to normal market forces. The aim is to provide representative projects in each of the major building sub-sectors rather than to demonstrate different aspects of the technology itself.

With dedicated control systems, the aim is to provide representative demonstrations of particularly novel control options (such as lighting and air-conditioning control) leaving better established techniques (such as heating control and electrical load management) to normal market forces.

This strategy presently envisages a total of 35 projects, 24 involving comprehensive e.m. systems and 11 dedicated controllers (8 for lighting, 2 for air-conditioning and 1 for ventilation).

The portfolio aims to help stimulate a target national energy saving of 912,000 tce/year out of the total economic potential of 2.0 Mtce/year for the whole technology. The presently estimated total cost to Government of the complete programme (ED grants plus independent monitoring costs) is £2.1M. Details are set out in Table 20.1.

Current status of the programme

Twenty five projects out of the envisaged total of 35 are currently under way. Details are summarised in Table 20.2. They represent a total financial commitment to Government of £1.64M. The long-term target national energy savings through replication of these existing projects is 727,000 tce/year.

The independent monitoring of lighting control projects has proceeded relatively smoothly because the savings have been substantial (20–40%), the fuel (electricity) easily measured and the results not strongly influenced by other factors. Four interim reports (on projects 10–13) have been received and two already published (on projects 10 and 11).

The monitoring of comprehensive e.m. system projects has, on the other hand, encountered severe technical problems, in particular separating the effects of installing such systems from all other influences on energy consumption such as weather, changes in building use and other energy efficiency improvement measures, etc. In some cases, it has proved extremely difficult to discern any definite savings at all.

Nevertheless, the value of the technology as a management tool to enable improved standards of operation and maintenance and to optimise the utilisation of all resources, including manpower, is beyond doubt. However, full and proper exploitation of the technology in this way is far from easy and requires substantial determination, skill and technical expertise.

Many prospective users, therefore, may not be in a position to make full use of these systems unless the adequate operator resources are allocated, appropriate training provided and the necessary administrative and managerial adjustments made.

The practical lessons arising from the demonstrations of e.m. technology so far have been encapsulated in a booklet — *Energy Management Systems,** published by the EEO in their Energy Technology Series. In addition, they have

*Available free from Enquiries Bureau, ETSU, Building 156, AERE, Harwell, Didcot, Oxon OX11 0RA.

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been publicised in a series of 10 major seminars around the UK also organised by the EEO.

Considerable interest has been stimulated in the technology as a result and equipment suppliers have reported substantial replication, much of which is directly attributable to ED activities. Orders for lighting control equipment are believed to be at least double what they would otherwise have been. The total national energy saving achieved through replication to date is estimated to be over 50,000 tce/year.

Future plans

The future plans for the programme entail completing the present portfolio of around 35 projects, bringing the monitoring exercises to successful conclusions and executing appropriate promotional efforts, particularly in priority areas, namely schools and offices.

Table 20.1 Electronic energy management systems: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
INDUSTRIAL SITES						
Medium sized sites	*	1	Comprehensive centralised energy management system (e.m.s.) on a pharmaceutical works — Reckitt & Colman	60	88	Ongoing
	*	2	Comprehensive centralised e.m.s. on an engineering works — Potterton International		52	
Small sized sites	*	3	Comprehensive low-cost distributed intelligence e.m.s. with peripherals — NEI Electronics	40	37	
	*	4	Comprehensive low-cost distributed intelligence e.m.s. without peripherals — Vickers Crabtree		30	
Lighting control	*	5	Time-based off-switching with manual reset in a cosmetics plant — Avon Cosmetics	30	10	
Tenanted factories	o	6	Comprehensive distributed intelligence network	20	90	
				150	307	
OFFICE BUILDINGS						
Medium sized sites	o	7	Comprehensive e.m.s.	40	40	
Small sized sites	o	8	Comprehensive low-cost e.m.s. with peripherals	40	23	
	o	9	Comprehensive low-cost e.m.s. without peripherals		22	
Lighting control	*	10	Time-based on/off switching of distribution circuits with photocell control — Portsmouth City Council	190	34	Ongoing
	*	11	Using reset switches with pull cords — Bradford Metropolitan City Council		34	
	*	12	Mains-borne on/off signalling plus photocell control and dimming — GEC Turbine Generators		32	
	*	13	Mains-borne off signalling plus photocell control and infra-red reset — Lloyds Bank		30	
	o	14	System appropriate for cellular offices		28	
	o	15	System with photoelectric dimming		30	
Air conditioning control	*	16	Chilled water temperature optimisation — Norwich Union	20	15	Ongoing
	o	17	Enthalpy economisation		13	
Tenanted offices	*	18	Comprehensive distributed intelligence bureau service e.m.s. network — Energy Technique	70	124	Ongoing
				360	425	
HOSPITALS						
Groups of small-medium sized sites	*	19	Comprehensive distributed intelligence e.m.s. network in 8 hospitals — Cornwall & Isles of Scilly Health Authority	100	141	Ongoing
	*	20	Comprehensive distributed intelligence e.m.s. network in 4 hospitals — Plymouth Health Authority		110	
				100	251	
RETAIL CHAIN STORES						
Supermarkets	*	21	Comprehensive distributed intelligence e.m.s. network in 5 stores — J Sainsbury	40	39	Ongoing
Banks	*	22	Comprehensive distributed intelligence e.m.s. network in 50 branches — Barclays Bank	30	152	
Non-food retail stores	o	23	Comprehensive distributed intelligence e.m.s. network	60	90	
Automotive dealerships	*	24	Low-cost centralised e.m.s. — Stormont Garages	17	23	
				147	304	

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Table 20.1 Electronic energy management systems: Proposed programme (continued)

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
SCHOOLS						
Groups of sites	*	25	Comprehensive distributed intelligence e.m.s. network with high monitoring capability in 9 large schools — Grampian Regional Council		158	
	*	26	Comprehensive distributed intelligence e.m.s. network in 50 schools — Hereford & Worcester County Council		163	
	*	27	Comprehensive distributed intelligence e.m.s. network in 3 coal-fired schools — Staffordshire County Council		22	Ongoing
	*	28	Comprehensive distributed intelligence e.m.s. network in 10 schools — Royal Borough of Kingston upon Thames	80	50	
	†		(Comprehensive distributed intelligence e.m.s. network in 20 schools — Essex County Council)			
Single sites	*	29	Comprehensive centralised control of an educational complex — Somerset County Council		64	Ongoing
Lighting control	*	30	Acoustic/photoelectric replacement light switches — Wolverhampton Borough Council		42	
				80	499	
NON-EDUCATIONAL LOCAL AUTHORITY PREMISES						
Homes for the elderly	*	31	Comprehensive distributed intelligence e.m.s. network in 6 residences — Norfolk County Council	20	49	Ongoing
Sports centres	+	32	Centralised comprehensive e.m.s., including ventilation/heat recovery control	10	35	
				30	84	
HOTELS AND OTHER COMMERCIAL						
Group of sites	*	33	Comprehensive distributed intelligence e.m.s. network in 15 hotels — Ladbroke Hotels	30	116	Ongoing
Large single site	o	34	Centralised comprehensive e.m.s. with individual room monitoring and control	15	80	
Entertainment buildings	*	35	CO_2 sensing for ventilation control in cinemas and bingo halls — Rank Leisure	20	22	
				65	218	
			TOTAL	932	2088	

KEY
* Existing project
\+ Prospective project
o Required project
† EEC project

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Table 20.2 Electronic energy management systems: Replication and energy saving targets for existing projects

Project	Project profile number	No of companies in target market	Energy savings (A) and required number of replications (B): Dec 85 A '000 tce/y	Dec 85 B No	June 88 A '000 tce/y	June 88 B No	Long term A '000 tce/y	Long term B No	Potential equipment suppliers
MEDIUM SIZED INDUSTRIAL SITES									
1 Comprehensive centralised e.m.s. on a pharmaceutical works — Reckitt & Colman	31	2000	40	80	50	100	60	120	Various. See *Energy Management Systems* — Energy Technology Series 1 or *Energy Management,* November 1983, published by the EEO and the Department of Energy.
2 Comprehensive centralised e.m.s. on an engineering works — Potterton International	103								
SMALL SIZED INDUSTRIAL SITES									
3 Comprehensive low-cost distributed intelligence e.m.s. with peripherals — NEI Electronics	57	8000	10	100	20	200	40	400	
4 Comprehensive low-cost distributed intelligence e.m.s. without peripherals — Vickers Crabtree	111								
LIGHTING CONTROL IN INDUSTRIAL SITES									
5 Time-based off-switching with manual reset in a cosmetics plant — Avon Cosmetics	138	8000	5	500	10	1000	30	3000	
LIGHTING CONTROL IN OFFICE BUILDINGS									
10 Time based on/off switching of distribution circuits with photocell control — Portsmouth City Council	27	10000	50	500	100	1000	190	2000	
11 Using reset switches with pull-cords — Bradford Metropolitan City Council	69								
12 Mains-borne on/off signalling plus photocell control and dimming — GEC Turbine Generators	87								
13 Mains-borne off signalling plus photocell control and infra-red reset — Lloyds Bank	102								
AIR CONDITIONING CONTROL IN OFFICE BUILDINGS									
16 Chilled water temperature optimisation — Norwich Union	8	2000	5	125	10	250	20	500	
TENANTED OFFICE BUILDINGS									
18 Comprehensive distributed intelligence bureau service e.m.s. network in 10 buildings — Energy Technique	127	500	20	40	40	80	70	140	
GROUPS OF HOSPITALS									
19 Comprehensive distributed intelligence e.m.s. network in 8 hospitals — Cornwall & Isles of Scilly Health Authority	68	200	60	120	100	200	100	200	
20 Comprehensive distributed intelligence e.m.s. network in 4 hospitals — Plymouth Health Authority	67								

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Tabe 20.2 Electronic energy management systems: Replication and energy saving targets for existing projects (continued)

	Project	Project profile number	No of companies in target market	Energy savings (A) and required number of replications (B): Dec 85 A '000 tce/y	Dec 85 B No	June 88 A '000 tce/y	June 88 B No	Long term A '000 tce/y	Long term B No	Potential equipment suppliers
	RETAIL CHAIN STORES									
21	Comprehensive distributed intelligence e.m.s. network in 5 supermarkets — J Sainsbury	12	200	30	60	40	80	40	80	
22	Comprehensive distributed intelligence e.m.s. network in 50 banks — Barclays Bank	162	10	3	2	5	4	30	22	
24	Low-cost centralised e.m.s. — Stormont Garages	ø	—	—	—	6	100	17	300	
	GROUPS OF SCHOOLS									
25	Comprehensive distributed intelligence e.m.s. network covering 9 schools with high monitoring capability — Grampian Regional Council	35								Various. See *Energy Management Systems* Energy Technology Series 1 or *Energy Management*, November 1983, both published by the EEO and the Department of Energy.
26	Comprehensive low-cost distributed intelligence e.m.s. network in 50 schools — Hereford & Worcester	62								
27	Comprehensive distributed intelligence network in 3 coal-fired schools — Staffordshire County Council	64	110 (Local Authorities)	20	8	50	20	80	30	
28	Comprehensive distributed intelligence e.m.s. network using a modular approach in 10 schools — Kingston upon Thames	132								
	SINGLE EDUCATIONAL SITES									
29	Comprehensive e.m.s. on a single educational complex — Somerset County Council	124								
	LIGHTING CONTROL IN SCHOOLS									
30	Acoustic/photoelectric replacement light switches — Wolverhampton Borough Council	149								
	NON-EDUCATIONAL LOCAL AUTHORITY PREMISES									
31	Comprehensive distributed intelligence e.m.s. network in 6 residences — Norfolk County Council	171	110 (Local Authorities)	1	3	5	15	20	60	
	HOTELS AND OTHER COMMERCIAL									
33	Comprehensive distributed intelligence e.m.s. network in 15 hotels — Ladbroke Hotels	102	20	5	10	10	20	30	60	
35	CO_2 sensing for ventilation control in cinemas and bingo halls — Rank Leisure	172	50+	2.5	50	12	240	20	400	
			TOTAL	251.5	1598	458	3309	747	7312	

ø Project profile not yet published

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Section 21 Public sector buildings (excluding office buildings)

(Mr D C Walden)

Energy use

Primary energy consumption in public sector buildings (excluding offices) is concentrated in educational buildings (6.2 million tonnes of coal equivalent per year (Mtce/year) — 175 PJ/year) and Health Service buildings (5.9 Mtce/year — 165 PJ/year). Primary energy is used for space and water heating (59%), for lighting (23%) and for catering and the operation of appliances (18%). Oil accounts for 38% of this energy use, electricity for 29%, gas for 22% and solid fuels for 11% (1979 data).

The scope for improved efficiency

The technological energy conservation potential in public sector buildings is about 50% of current consumption. The economic conservation potential at current fuel prices is approximately 30% of consumption. Apart from the introduction of heat pumps and microprocessor-based technologies (discussed in sections 11 and 20), this potential will largely be realised by improved management and by more widespread implementation of existing energy conservation technologies, such as fabric insulation, draught-proofing, heat recovery and improved local controls of boiler, heat distribution and lighting systems.

The major role of demonstration is to confirm, in practice, the energy savings achieved by packages of these measures in buildings typical of large, homogenous parts of the public sector buildings stock.

Proposed programme and energy saving targets

The programme is to provide improved performance information by two methods:

- Monitored demonstration projects, where these can confidently be expected to improve on current knowledge and predictive capability.
- Evaluation of the rapidly growing body of fuel use data now being collected by building managers, again with the aim of testing and improving current prediction methods.

Table 21.1 summarises the proposed programme of seven demonstrations/studies in educational buildings, one demonstration concerned with various building types and the demonstration of improving combustion efficiency in older pattern cast iron sectional boilers. The number of demonstrations/studies may increase in the future depending on the conclusions from the current programme. It should be noted that demonstrations of energy management systems are discussed in section 20. The long term energy saving target of 310,000 tce/year is at a cost to Government of £749,000.

Current status of the programme

The current status of each existing project is referred to in Tables 21.1 and 21.2 where promotion start dates and both short and long term energy saving targets and the number of replications required are given.

A. *Educational Buildings*

Monitoring of the Birmingham Diocesan Education Council's linked schools at Sutton Coldfield has been completed. A final report is being prepared for publication. The other schools projects are in progress. A study of school energy records of the Greater London Council (GLC/ILEA) and Cheshire County Council has been carried out under the lead consultancy contract and a report will be published to complement the formal demonstration projects.

B. *Miscellaneous Public Sector Buildings*

The demonstration of boiler flue baffles has already begun to stimulate replication and a workshop took place in February 1984 further to promote the results from this project. The aerial infra-red thermography survey project is now complete: a final report has been received from the contractor and awaits discussion with the host Local Authority before being published.

Future plans

It is unlikely that the programme in educational buildings will be expanded before 1984/5. Required projects in this sector, as identified to date, are shown in Table 21.1.

Projects within Health Service buildings will also be considered. These will complement the current demonstrations of energy management systems, the single project concerned with heat recovery from a hospital laundry and the energy conservation programme of the Department of Health and Social Security.

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Table 21.1 Public sector buildings (excluding office buildings): Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
EDUCATIONAL BUILDINGS						
Thermally heavyweight construction						
(i) New build	*	1	Energy conservation package in two linked schools, at Sutton Coldfield, West Midlands	20	179	Apr 1984
(ii) Circa 1900	*	2	Energy conservation package in a school at Hither Green, London	25	71	Sept 1984
Thermally lightweight construction circa 1965	*	3	Energy conservation package in two system-built schools in Hampshire	80	95	Sept 1985
Ventilation/heat recovery	*	4	Reduction of ventilation rate and heat recovery from ventilation air in a school at Clacton, Essex	5	81	Mar 1985
	o	6	Studies to optimise window area/lighting use and boiler plant configurations	20	50	
	o	7	Condensing boiler systems in schools	20	50	
	*		(O_2 trim control on a gas-fired boiler — University of Sussex)	(200)	(13)	
Groups of sites	*		(Comprehensive distributed intelligence e.m.s. network with high monitoring capability in 9 large schools — Grampian Regional Council)		(158)	Ongoing
	*		(Comprehensive distributed intelligence e.m.s. network in 50 schools — Hereford & Worcester County Council)		(163)	
	*		(Comprehensive distributed intelligence e.m.s. network in 3 coal-fired schools — Staffordshire County Council)		(22)	
	*		(Comprehensive distributed intelligence e.m.s. network in 10 schools — Royal Borough of Kingston upon Thames)	(80)	(50)	
	†		(Comprehensive distributed intelligence e.m.s. network in 20 schools — Essex County Council)			
Single sites	*		(Comprehensive centralised control of an educational complex — Somerset County Council)		(64)	Ongoing
Lighting control	*		(Acoustic/photoelectric replacement light switches — Wolverhampton Borough Council)		(42)	
				170	526	
MISCELLANEOUS BUILDINGS	*	8	Aerial infra-red thermography survey of the London Borough of Ealing	40	66	May 1984
	*	9	Installation of flue baffles in older pattern cast iron sectional boilers — Coventry City Council	30	11	Feb 1984
	*	10	Condensing boilers in a hospital — Brent Area Health Authority	20	96	
	+	11	Retrofit heat recovery to standby plant for combined heat and power in hospitals	50	50	
Swimming Pools	*		(Gas engine dehumidifier — Rushmoor Borough Council)		(63)	
	*		(Gas engine dehumidifier — Wandsworth Borough Council)	(50)	(53)	
	*		(Gas engine dehumidifier — Ettrick & Lauderdale D C)		(39)	
				140	223	
			TOTAL	310	749	

KEY
* Existing project
\+ Prospective project
o Required project
† EEC project

NB Items and values in brackets are not included in the above totals. They are incorporated in the figures for other technologies elsewhere in the document.

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Table 21.2 Public sector buildings (excluding office buildings): Replication and energy saving targets for existing projects

	Project	Project profile number	No of companies in target market	Energy savings (A) and required number of replications (B): Dec 85		June 88		Long term		Potential equipment suppliers
				A '000 tce/y	B No	A '000 tce/y	B No	A '000 tce/y	B No	
	EDUCATIONAL BUILDINGS									
1	Energy conservation in two linked schools — Sutton Coldfield	11	110 Local Education Authorities with total of 30,000 schools	3	130	8	300	20	800	Suppliers of insulation, draught-proofing, heating system, boiler plant and lighting controls
2	Energy conservation in a school at Hither Green, London	119		1	50	5	250	25	1,200	
3	Energy conservation in two system-built schools in Hampshire	163		4	60	13	200	80	1,200	
4	Reduction of ventilation rate and heat recovery from ventilation air in a school at Clacton	104		0.3	20	1	100	5	500	
	MISCELLANEOUS BUILDINGS									
8	Aerial infra-red thermography survey of the London Borough of Ealing	84	UK urban areas	5	5	15	15	40	40	Clyde Surveys Ltd, DBM Surveys Ltd, Hunting Geology and Geophysics Ltd
9	Installation of flue baffles in older pattern cast iron sectional boilers — Coventry City Council	5	Local Authorities and industry with 60,000 boilers	10	5,000[1]	30	15,000[1]	30	15,000[1]	Metal fabrication companies
10	Condensing boilers in a hospital — Brent AHA	ø		—	—	5	10	20	40	
			TOTAL	23.3	5,265	77	15,875	220	18,780	

ø Project profile not yet published
[1] Number of boilers

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Section 22 Office buildings

(Mr D C Walden)

Energy use

Primary energy consumption in UK office buildings is composed of approximately equal consumptions in the commercial and public sectors (5.1 and 5.6 million tonnes of coal equivalent per year (Mtce/year) respectively — 145 and 155 PJ/year). Energy is used in offices for space and water heating (59%), for lighting (23%) and for catering and the operation of appliances (18%). In the commercial office sector oil accounts for 18% of primary energy use, electricity for 66%, gas for 13% and solid fuels for 3%. In the public sector oil accounts for 45% of primary energy use, electricity for 28%, gas for 14% and solid fuels for 13% (1979 data). Since 1979, gas has probably replaced oil to some extent in both office sectors.

The scope for improved efficiency

The technological energy conservation potential in office buildings is about 50% of current consumption. The economic conservation potential at current fuel prices is approximately 20–30% of consumption. Microprocessor-based technologies apart (discussed in section 20), this potential will largely be realised by improved management and more widespread implementation of existing energy conservation technologies, for example fabric insulation, draught-proofing, heat recovery and improved local controls of boiler, heat-distribution and lighting systems.

The major role of demonstration in the heterogeneous UK office buildings stock is to establish that the cost-effectiveness of conservation measures can be predicted with reasonable confidence by building estate managers.

Proposed programme and energy saving targets

The programme is to improve confidence in predicting the performance and cost-effectiveness of conservation measures by two methods:

- Comparison of the predictions of the simplest, adequate calculation procedures with the results of conservation programmes already carried out in major office buildings estates, for example, the Property Services Agency (PSA) estate.
- Modelling or field monitoring (demonstration) projects, designed to resolve uncertainties shown by these comparisons or to demonstrate either novel technologies or existing technology in new applications.

Table 22.1 summarises the proposed programme of two existing and one prospective demonstration in public sector offices and shows the long term energy saving target from these three projects to be 40,000 tce/year at a cost to Government of £58,000. In addition to these projects, energy management systems and lighting and air conditioning control systems are also being demonstrated in office buildings, and the respective figures for these are discussed in section 20.

The energy use and potential for cost-effective energy conservation in the existing office buildings stock is currently being assessed in conjunction with consulting engineers Ove Arup and Partners. The average size of an individual commercial office property is around 250 m² but 47% of the total floor area, and so virtually half the energy consumption is in properties with an area greater than 1000 m². Small offices of less than 100 m², while accounting for 60% of the total by number, only form 12% of the overall floor area. Hence from an energy conservation viewpoint, the key element of this category of non-domestic buildings is medium and large offices. The average size of central government offices is about 1000 m² and, although no size breakdown has been obtained, it is clear that this reflects the relatively few small central government offices. It is considered that local government and nationalised industry offices lie somewhere between these two extremes. It follows that in both the commercial and public office sectors, large offices and perhaps also medium-to-large offices (300–1000 m²) offer the greatest potential for energy conservation. Although air-conditioned offices typically use 80% more energy per unit floor area than those with heating only, they only account for perhaps 3% of the total floor area and so initially would not be considered one of the priority areas for future demonstrations.

Table 22.1 also summarises those projects that are considered to be required. This priority list is provisional and may be amended when the study by Ove Arup and Partners has been completed. A study of energy records in office building estates is required to improve estimates of savings from energy conservation measures already installed. Following this study a number of demonstrations may be appropriate, in particular on ventilation reduction, control and heat recovery. A second demonstration of low energy office design principles, possibly in a commercial office, may also be justified. Including these projects with those discussed above, the total long term energy saving target is shown in Table 22.1 to be 340,000 tce/year at a cost to Government of approximately £350,000.

Current status of the programme

The current status of each existing project is referred to in Tables 22.1 and 22.2 where promotion start dates and both short and long term energy saving targets and the number of replications required are given. The number of replications is based on an average office building floor area of 400 m² (considering both commercial and public sector offices) and this will vary depending on the size of those buildings influenced by the demonstrations.

Monitoring of both the localised lighting and the low energy office projects have been completed. Final reports on both projects should be available by the end of 1984.

Future plans

The main short term task is to complete the study on the energy use and potential for cost-effective energy

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conservation in the existing office buildings stock. The conclusions from this study should identify the main types of offices in terms of construction, size, age and type of heating system and those energy conservation measures most appropriate to each office category. A programme of demonstrations will then be defined and implemented based on these findings.

Table 22.1 Office Buildings: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
PUBLIC OFFICE BUILDINGS	*	1	Localised lighting installation in a multi-occupant office at Gwent County Council, Cwmbran	20	21	Apr 1984
	*	2	Demonstration of low energy office design principles in the low energy office at the Building Research Establishment, Watford	10	12	Apr 1984
	*	3	Retrofit energy conservation measures in a multi-storey office block at Cheshire County Council, Warrington	10	25	Mar 1986
				40	58	
PUBLIC AND COMMERCIAL OFFICE BUILDINGS						
Existing medium/large buildings	o	4	Study of energy records in office buildings estates to estimate savings from energy conservation measures already installed	125	10	
	o	5	Ventilation reduction in a naturally ventilated office	50	150	
	o	6	Ventilation reduction, control and heat recovery in mechanically ventilated offices			
	o	7	Boiler plant efficiency improvements (retrofit and replacement)	30	30	
	o	8	Fabric insulation/glazing area reduction	30	40	
	o	9	Retrofit space heating controls	15	30	
New medium/large offices	o	10	Low energy design in a commercial sector office	50	30	
Medium sized sites	o		(Comprehensive e.m.s.)	(40)	(40)	
Small sized sites	o		(Comprehensive low-cost e.m.s. with peripherals)	(40)	(23)	
	o		(Comprehensive low-cost e.m.s. without peripherals)		(22)	
Lighting control	*		(Time-based on/off switching of distribution circuits with photocell control — Portsmouth City Council)	(190)	(34)	
	*		(Using reset switches with pull cords — Bradford Metropolitan City Council)		(34)	
	*		(Mains-borne on/off signalling plus photocell control and dimming — GEC Turbine Generators)		(32)	
	*		(Mains-borne off signalling plus photocell control and infra-red reset — Lloyds Bank)		(30)	
	o		(System appropriate for cellular offices)		(28)	
	o		(System with photoelectric dimming)		(30)	
Air conditioning control	*		(Chilled water temperature optimisation — Norwich Union)	(20)	(15)	
	o		(Enthalpy economisation)		(13)	
Tenanted offices	*		(Comprehensive distributed intelligence bureau service e.m.s. network — Energy Technique)	(70)	(124)	
				300	290	
			TOTAL	340	348	

KEY * Existing project
o Required project

Items and values in brackets are not included in the above totals. They are incorporated in the figures for other technologies elsewhere in the document.

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Table 22.2 Office buildings: Replication and energy saving targets for existing projects

Project	Project profile number	No of companies in target market	Energy savings (A) and required number of replications (B) Dec 85 A '000 tce/y	Dec 85 B No	June 88 A '000 tce/y	June 88 B No	Long Term A '000 tce/y	Long Term B No	Potential equipment suppliers
PUBLIC OFFICE BUILDINGS									
1 Localised lighting installation, Gwent County Council, Cwmbran	90	Public and commercial office owners	2	250	10	1200	20	2500	Major manufacturers of lighting equipment
2 Low energy office, Building Research Establishment, Watford	91		2	50	5	200	10	400	Projects aimed at design principles rather than particular types of equipment
3 Retrofit energy conservation measures in a multi-storey office block — Warrington	ø		—	—	2	60	10	300	
		TOTAL	4	300	17	1460	40	3200	

ø Project profile not yet published

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Section 23 Commercial buildings (excluding offices)

(Dr M J Butson)

Energy use

Private sector commercial buildings (excluding offices) consume about 21 million tonnes of coal equivalent (Mtce)/year (580 PJ/year). The major sub-divisions are hotels/catering (6.2 Mtce/year — 170 PJ/year) and distributive trades/entertainment (9.2 Mtce/year — 250 PJ/year). Both these categories contain several discrete sub-sectors, each with a characteristic structure and pattern of energy use. A significant feature is that two thirds of the primary energy is electricity, used in lighting, refrigeration and other appliances as well as for some of the heating and cooking (oil and gas each account for about 15% of the total primary consumption).

This sector is labour- rather than energy-intensive: fuel costs account for a relatively small percentage of turnover (5–10% in hotels and often less than 1% in the retail trade), but can be a significant proportion of operating costs. While these 'service' industries are a significant growth area of the economy, expansion tends to be focused in the major store, hotel and fast-food groups rather than the smaller individual hotels, restaurants and shops which actually account for a large proportion of the sector's energy consumption.

There is fierce competition among the larger groups which have recognised that energy conservation can be an effective way of improving not only their market positions (almost all have active energy managers) but also their general image (e.g. Tesco 'TEAM' awards). These companies have generally become more energy-efficient since 1973, but expansion and consumer trends (e.g. to more frozen food) have meant that, taken overall, the consumption in larger stores has increased. Smaller, individual premises have generally mirrored the domestic rather than the commercial sector: little information is available, but it is unlikely that there have been significant improvements since 1973.

The scope for improved efficiency

It is estimated that the technical potential for conservation in the commercial sector is 50% (10.5 Mtce/year): however, this is undoubtedly a long-term prospect because of the disaggregated nature of the sector, with large numbers of different consumers and uses of energy. Substantial savings should be achieved through the use of cost-effective measures retrofitted to building fabric (e.g. insulation) and services (e.g. low energy lighting): the economic potential is therefore assessed at 5 Mtce/year.

Research, development and demonstration is likely to have the most immediate impact on the larger groups, who are generally receptive to conservation initiatives and see payback periods of up to 3 or 4 years as attractive: it is likely that the major novel developments will be in building services, including heat recovery, heat pumps and control. In the smaller shops and hotels there is a very basic requirement for demonstration of simple, cost-effective building fabric, services and management measures: these would not be regarded as novel by the more sophisticated larger companies, but to these smaller businesses the novelty and risk are very real.

Proposed programme and energy saving targets

It has proved more difficult than expected to establish an effective demonstration programme in the commercial sector. Interest in the demonstration scheme has now been stimulated in many large business groups, and more worthwhile proposals are coming forward to the Energy Technology Support Unit (ETSU). However, smaller companies (with less financial incentive to stimulate their interest in energy conservation) remain ignorant of the Scheme and how it can help them: a different approach is clearly needed in this area. It is therefore particularly important to retain flexibility in the planning and initiation of the programme, so that the emphasis can be changed in the light of experience and market developments.

It is envisaged that the demonstration plan for the commercial sector might consist of 30 projects (Table 23.1). The cost to Government would be over £1.3M and the potential energy saving target 778,000 tce/year (5% of the total energy use for the sector). The projects are exclusively in the two main building categories, hotels/catering and retail trades/entertainment.

The main priority is retrofit projects involving building services, particularly where they can be used to build up a comprehensive package of projects within a specific sub-sector: these projects offer the advantages of a relatively large potential market (compared with new-build), relatively low monitoring costs (compared with projects involving building fabric measures), and hopefully a rapid market penetration following co-ordinated promotion. A second priority is the establishment of demonstrations of energy management as a consultancy service to small businesses whose fuel costs are not high enough to justify in-house training or management activities: this appears to be the only way in which the Energy Efficiency Demonstration Scheme could have an impact in an area where much energy is used but management standards are currently low.

Current status of the programme

The commercial sector programme currently consists of nine projects: these represent a commitment of £422,000 by the Energy Efficiency Office and offer target savings of 163,000 tce/year (Table 23.2). They are supported by a further five demonstrations of applications of energy management in commercial buildings and by a number of other projects directed at the same market. It is significant that all the projects so far considered have come from major groups, although some proposals now being developed would, if supported, substantially broaden the scope of the programme.

Future plans

The main objectives for the future development of the commercial buildings programme are:

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1. To complete effective 'packages' of projects in both major building categories.
2. To take new initiatives aimed specifically at smaller commercial buildings.
3. To develop new projects intended to capitalise on major opportunities for improving energy efficiency (particularly refurbishment and new-build).

It is estimated that it should be possible to implement 28 projects by the end of 1985/6: twenty of these projects would be technically complete and entering the promotional phase by that time.

Table 23.1 Commercial buildings (excluding offices): Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
LEAD CONSULTANTS	*		Lead consultants (Energy Conscious Design)		150	
HOTELS & CATERING Fabric, services & management	o	1	Low energy design of a new hotel	40	60	
	o	2	Low energy design of a new public house	40	30	
	o	3	Energy efficiency refurbishment of an hotel	50	50	
	+	4	Energy efficiency refurbishment of public houses	70	40	
	o	5	Energy efficiency refurbishment of chain/fast-food outlets	30	30	
				230	210	
Services retrofit	o	6	High efficiency lighting in hotels and public houses	30	30	
	o	7	Energy efficient catering equipment in restaurants/hotels	40	30	
	*		(A low-energy laundry — Wessex Regional Health Authority)	(12)	(42)	
				70	60	
Heat recovery & heat pumps	*	8	Run-around coils for kitchen ventilation heat recovery — Devon CC	10	45	Mid 1985
	*	9	Heat pump for kitchen ventilation heat recovery — Welcome Break	8	30	Mid 1985
	o	10	Heat pipes for kitchen ventilation heat recovery	20	30	
	o	11	Heat recovery from dishwashers	20	40	
	*	12	Heat pumps for cellar cooling and d.h.w. — Allied Breweries	25	35	End 1984
	o	13	Heat pumps for food refrigeration and domestic hot water	20	40	
	*		(Heat recovery from laundry effluent — Belgrave Laundry)	(8)	(24)	
				103	220	
Electronic energy management & control systems	*		(Comprehensive distributed e.m.s. in hotels — Ladbrokes)	(30)	(116)	
	+		(Centralised electronic e.m.s. in a large hotel)	(15)	(80)	
Small scale combined heat and power (CHP)	*	14	Small scale CHP (Totem) in a large hotel — Trusthouse Forte		82	
	*	15	Serck micro-CHP systems in 5 applications		75	
	*	16	Watermota micro-CHP systems in 2 applications		29	
	*	17	Holec micro-CHP systems in 2 applications	100	31	
	*	18	Applied Energy Systems micro-CHP systems in 2 applications		40	
	+	19	Denco micro-CHP systems in some applications		45	
	+	20	Micro-CHP system with grid transmission to other sites		20	
				100	322	
			SECTOR SUB-TOTAL	503	812	

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Table 23.1 Commercial buildings (excluding offices): Proposed programme (continued)

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
RETAIL & OTHER BUILDINGS						
Fabric, services & management	+	21	Low energy design of new supermarket	30	70	
	o	22	Energy efficient refurbishment of a department store	20	70	
	o	23	Energy efficient refurbishment of smaller shops and stores	60	40	
	o	24	Energy efficient refurbishment of entertainment buildings	40	60	
	+	25	Energy management in a shopping mall/centre	20	80	
				170	320	
Services retrofit	o	26	High-efficiency sales/display lighting in retail premises	30	25	
	o	27	Freezer/cold-room design and control in warehouses	15	40	
	o	28	Lighting and lighting control in entertainment buildings	15	25	
	*		(Waste as a fuel in a department store — Schofields)	(30)	(55)	
	*		(Insulated trucks for milk delivery — Magness & Usher)	(13)	(20)	
				60	90	
Heat recovery & heat pumps	*	29	Heat recovery and improved control in shops — W H Smith	20	55	
	o	30	Dehumidification for warehouse environment control	25	40	
	*		(Heat recovery from washing machines — Fabricare)	(8)	(11)	
				45	95	
Electronic energy management & control systems	*		(Comprehensive distributed e.m.s. in supermarkets — Sainsbury)	(40)	(39)	
	o		(Comprehensive distributed e.m.s. in non-food stores)	(60)	(90)	
	*		(Comprehensive distributed e.m.s. in banks — Barclays)	(30)	(150)	
	*		(Electronic energy management in the motor trade — Stormont Garages)	(17)	(23)	
	*		(CO_2 sensing for ventilation control in cinemas and bingo halls — Rank Leisure)	(20)	(22)	
			SECTOR SUB-TOTAL	275	505	
			TOTAL	778	1317	

KEY * Existing project
+ Prospective project
o Required project

NB Items and values in brackets are not included in the above totals. They are incorporated in the figures for other technologies elsewhere in the document.

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Table 23.2 Commercial buildings (excluding offices): Replication and energy saving targets for existing projects

Project	Project profile number	No of companies in target market	Energy savings (A) and required number of replications (B)						Potential equipment suppliers
			Dec 85		June 88		Long term		
			A '000 tce/y	B No	A '000 tce/y	B No	A '000 tce/y	B No	
8 Run-around coils for kitchen ventilation heat recovery — Devon CC	112	3,000	1.2	25	5.0	100	10.0	200	Jenks and others (not identified)
9 Heat pump for kitchen ventilation heat recovery — Welcome Break	ø	3,000	0.6	25	3.5	150	8.0	350	Tricool Engineering and others (not identified)
12 Heat pumps for cellar cooling and dhw — Allied Breweries	117	100,000*	3.0	1,000	15.0	5,000	25.0	7,500	F H Biddle, Water Mota, possibly others
14 Small scale CHP (Totem) in a large hotel — Trusthouse Forte	161								
15 Serck micro-CHP systems in 5 applications	ø								Fiat, Serck, Applied Energy Systems, Water Mota Denco, Holec.
16 Watermota micro-CHP systems in 2 applications	ø	1,000	8.0	250	45.0	1,300	100.0	3,000	
17 Holec micro-CHP systems in 2 applications	ø								
18 Applied Energy Systems micro-CHP systems in 2 applications	ø								
29 Heat recovery and improved control in shops — W H Smith	168	20,000	3.0	80	14.0	350	20.0	500	
		TOTAL	15.8	1,380	82.5	6,900	163.0	11,550	

ø Project profile not yet published
* Number of premises

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Section 24 Industrial buildings

(Mr J Condliffe)

Energy use

The heating, lighting and operating of industrial buildings accounts for nearly three times as much primary energy consumption as any other single category of building. Of the total 21.5 million tonnes of coal equivalent (Mtce)/year (600 PJ/year) used in these buildings 45% is supplied as oil, 24% as electricity, 21% as gas and 10% as solid fuel. Approximately 79% of this energy is used as space and water heating, 14% for lighting and 8% for ancillary appliances.

The scope for improved efficiency

Although this category of non domestic buildings has the highest energy consumption, it is also the most disaggregated in terms of the wide variations in energy consumption between different sites. The factors influencing the use of energy within specific industrial buildings are inter-related, and it is therefore difficult to identify the particular types of building in which conservation might have the greatest effect.

Most of the energy consumed by industrial buildings will be lost either because the losses are unavoidable, or because it is impracticable or uneconomic to reclaim it. A cautious but realistic estimate puts the maximum technological potential of energy savings that can probably be achieved at around 6 Mtce/year. Little detailed and reliable information is available but we can break this down into broad categories as follows:—

	Mtce/year
Improved insulation	1.5
Heat recovered from controlled ventilation	1.2
Heat recovered from fume extraction	0.4
Improvements to lighting	0.9
Heat recovered from services (plant)	0.3
Improvements in efficiency of present practice	0.9
Heat recovered from: water services	0.3
other	0.5

In addition there is the possibility of recovering around 0.7 Mtce from process plant for use as heating within buildings, mainly in the engineering industries.

Proposed programme and energy saving targets

Several different technologies contribute to energy conservation in buildings and each is supported by its own separate and distinct supply industry. The response to conservation opportunities by investors is varied and depends mainly on the cost effectiveness of the measure and to a lesser extent on the drive of the equipment manufacturers.

This results in a situation where, in some areas, attempts to stimulate a dead market will be wasteful of resources and, in others, it will be necessary and beneficial to seek out suitable demonstration projects.

Because of the relatively slow turnover in building stock the majority of the energy savings in the foreseeable future will come from retrofit measures. A great deal can be done simply by improving the efficiency of existing installations, but that activity falls outside the remit of the Demonstration Scheme and is more appropriately tackled under the one day and extended survey schemes.

Air movements

In industrial buildings over half of the energy losses are due to air movements and air infiltration: however, the standards of air tightness and the need to improve them varies considerably depending on the use to which the building is put and its occupancy pattern. The potential impact that this sector can have on energy conservation is therefore at least as great as any other sector, but the difficulties of coming to terms with it in a practical sense are also greater.

Some demonstrations have been approved in this sector; these seek to reduce the temperature gradients within buildings by recirculation, and to contain losses by the close control of large loading doors. Further demonstrations, possibly as many as 6 in total, may be appropriate: these will aim to up-grade the standards of air tightness, reduce temperature differentials, or reduce the number of air changes required (Table 24.1).

Insulation

The potential for saving energy by improving insulation is also high: however the need to do so depends upon the standard of construction, the industrial process it houses, and the occupancy pattern. Although investment in retrofit insulation may be justified on energy conservation grounds, replication of demonstrations may be retarded in many instances by relatively long payback times or the unsuitability of the site or influence of the process.

The industrial buildings sector already contains a number of projects for the insulation of various types of process buildings. These were set up to validate the Factory Heating Target Programme and should yield valuable information on the effectiveness of insulating factory buildings.

Energy management systems

It is expected that some of the potential savings will come from the introduction of energy management systems to control heating plants, lighting and ventilation rates. These projects have been discussed in Sections 17 and 20.

Heat recovery

There are a number of well established heat recovery techniques available; the technical aspects are well understood and the markets established. In spite of this the growth rate of the industry is low due to the relatively long payback times of retrofitted equipment. A large part of the market is in refurbishing and new installation where most of the capital costs can be offset again non-heat recovery installations. There is little or no need for demonstrations to stimulate these tried and tested technologies.

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Due to low natural gas prices, the relatively low annual heating loads caused by the mild climate, and high first cost, the heat pump is not generally competitive under UK conditions. Currently it is competitive only for special applications such as swimming pools, some air conditioned buildings and where a quantity of low level waste heat is available. The opportunities for demonstrating heat pumps in industrial buildings are limited and will probably be confined to a few specialist buildings with high throughputs of warm air or to recovery from industrial processes for space heating.

New builds
The low energy design of new industrial buildings has a smaller conservation potential than retrofit packages. However, demonstrations will still be justified where there are specific technological, economic or institutional barriers to the widespread adoption of low energy designs. It is suggested that a small programme of perhaps 3 projects may be appropriate in this area.

Programme targets
Some of the savings contained in the estimated maximum technological potential of 6 Mtce/year will be achieved by measures taken outside the remit of the Demonstration Scheme. The influence of the economic climate and the probability of replication also cannot be ignored when considering the programme target for demonstrations in industrial buildings.

A sensible target for the whole of the industrial buildings programme would therefore be to aim for replication to achieve savings in the region of 1.3 Mtce/year. A breakdown of this target by technologies is given in Table 24.1. It is suggested that the total number of projects required to achieve these savings will be in the region of 34 with a total cost to Government of £1.3M.

Current status of the programme

The current programme has 14 approved demonstration projects (excluding those in the Energy Management Systems programme) which, if successful in achieving the set targets, will save 528,000 tce/year. The programme is therefore at the halfway stage both in the number of projects required and the estimated target savings.

Future plans

Some aspects of the programme in industrial buildings, such as the provision of insulation and energy management systems, are adequately covered for the time being at least by the present packages of projects. There will therefore be a change of emphasis in the programme strategy from that put forward previously. As standards of insulation and control improve, losses through air movement and the recovery of low-grade heat assume greater importance. However, good technical demonstrations in these areas are likely to prove difficult both to find and to monitor.

Table 24.1 Industrial buildings: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
BUILDING FABRIC						
Insulation	*	1	Insulation at BICC		26	
	*	2	Insulation at Anderson Strathclyde		5	
	*	3	Insulation at Cryoplants		12	
	*	4	Insulation at Newage		18	Autumn 1984
	*	5	Insulation at Cumbria Engineering	100	74	Summer 1984
	*	6	Insulation at Marconi		18	Summer 1984
	*	7	Insulation at GEC Power		17	
Controls	*	8	Control improvements at Gould Advance		16	Autumn 1984
	*	9	Control improvements at Sheffield Twist Drill		25	
	*	10	Control improvements at NEI		58	
				100	269	
CONTROL OF AIR MOVEMENTS					106	Autumn 1984
Reduction of temperature gradients	*	11	BHRA project (6 sites)			
	+	12	Novel destratification system	100	29	
Reduction door losses	*	13	BSRIA (10 sites)		162	Autumn 1984
Reduction air changes	o	14	To demonstrate savings consequent			
	o	15	upon improvements	150	200	
Increase air tightness	o	16	in control of air movements			
	o	17				
				250	497	
HEATING						
Novel heating	*	18	High level radiant heating — British Caledonian	100	29	Autumn 1984
				100	29	

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Table 24.1 Industrial buildings: Proposed programme (continued)

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
ENERGY MANAGEMENT SYSTEMS (for reference)	*		(Reckitt & Colman)	(60)		
	*		(Potterton International)			
	*		(NEI)	(40)		
	*		(Vickers)			
HEAT PUMPS (for reference)	o		(Demonstrations of heat pumps for low grade heat — process heat recovery)	(300)	(150)	
	o					
	o					
	o					
NEW BUILD Low energy factory design	*	19	Welsh Development Agency	38	52	Spring 1985
	o	20		40	100	
	o	21				
				78	152	
			TOTAL	528	947	

KEY * Existing project
o Required project
+ Prospective project

NB Items and values in brackets are not included in the above totals. They are incorporated in the figures for other technologies elsewhere in the document.

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Table 24.2 Industrial buildings: Replication and energy saving targets for existing projects

Project	Project profile number	No of companies in target market	Dec 83 A '000 tce/y	Dec 83 B No	June 88 A '000 tce/y	June 88 B No	Long term A '000 tce/y	Long term B No	Potential equipment suppliers
1 Insulation at BICC 2 Insulation at Anderson Strathclyde 3 Insulation at Cryoplants 4 Insulation at Newage 5 Insulation at Cumbria Engineering 6 Insulation at Marconi 7 Insulation at GEC Power 8 Control improvements at Gould Advance 9 Control improvements at Sheffield Twist Drill 10 Control improvements at NEI 11 Reduction of temperature gradients — BHRA 13 Reduction of door losses — BSRIA	ø	Very many	20	120	50	300	100	600	Numerous
18 High level radiant heating — British Caledonian	182	Very many	5	16	30	100	100	500	Several (10)
19 Low energy factory design — Welsh Development Agency	173	4 national development agencies also private developers	—	—	2	20	38	400	N/A
		TOTAL	25	136	82	420	238	1500	

ø Project profile not yet published

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Section 25 Domestic buildings

(Mr J R Britten, BRECSU)

Energy use

Primary energy use in the domestic sector is estimated at 28% of the UK total (1980 figures), ie approximately 96 million tonnes of coal equivalent (Mtce)/year or 2,536 PJ. In terms of delivered energy (1,668.8 PJ), 53% of the energy is provided by natural gas, about 21% by solid fuel, 18% by electricity and only 7% by petroleum. The primary fuel equivalents are 37%, 15%, 43% and 5% respectively.

The major use of the delivered energy, accounting for about 60% of consumption, is for space heating, with approximately 22% being applied to water heating, 10% for cooking and lighting, and the remaining 8% for all other domestic uses, including domestic appliances and leisure apparatus. The approximate breakdown in terms of primary fuel equivalent is space heating 48%, water heating 21%, cooking and lighting 12% and all others 17%.

The above figures relate to the 'domestic sector' but, as with other major sectors of the economy, this sector is non homogeneous and the figures conceal wide variation between users. The total number of households may be taken as 20 million, with a mean household size of 2.68 persons, but (eg) the 13% of households containing 3 or more adults of working age will have different energy demands from the similarly sized group of households containing at least one child below the age of 4.

Similarly the form, style, and age of construction has a significant impact on energy use, with detached houses consuming proportionately more energy for space heating than do (eg) mid floor flats. Other factors such as climate, tradition, and the availability of particular fuel types also modify the energy use pattern, and so it is helpful to disaggregate the total into different groupings when considering the need for demonstration projects.

The scope for improved efficiency

It has been estimated that at least 25% of domestic energy consumption could be 'saved' by the end of the century, without any reduction in environmental standards or levels of comfort. A further saving of 15% is technically possible, and might be achieved cost-effectively in the following 20 years. This estimate reflects the fact that some householders will prefer to make more efficient use of energy, or to live more comfortably, rather than taking the full benefit of energy conservation in financial terms. This is particularly true of lower income groups who are only able to spend a small and fixed amount on heating.

When making these estimates, it was assumed that the Energy Efficiency Demonstration Scheme would continue as one means of increasing awareness of energy conservation, and it was further estimated that the 25% saving referred to above could be achieved by utilising the following technologies: insulation and above related measures (leading to savings of 10%); better controls, better housekeeping, improved appliances (6%); control of air infiltration and of waste heat recovery (4%); improvements to water heating systems (4%) and miscellaneous electrical and lighting improvement (1%).

Savings are possible in both new building and existing housing. Building regulations have forced an improvement to overall U-values of new buildings, and so the scope for additional cost-effective insulation is somewhat reduced in these buildings. However the design freedom available in new building allows further measures to be incorporated reasonably cheaply. It is likely that 6 Mtce/year could be 'saved' by the energy efficient design of new buildings. A further 7 Mtce/year is available by major rehabilitation of existing properties, 12 Mtce/year by minor improvement and maintenance and 5 Mtce/year by the replacement of heating systems.

Local authorities and other large housing organisations (eg housing associations) can influence energy conservation practice more widely than individual users, although the overall scope for conservation is much greater in the private sector. For example in the improvement and rehabilitation of existing housing it is believed the private sector could save almost 17 Mtce/year against 8 Mtce from the public sector.

Progress in energy conservation to date

In both public and private sector housing there has been evidence of a response to energy conservation, and considerable progress has been made with basic insulation techniques, eg 70% of the homes suitable for loft insulation now have *some* level of insulation fitted, and over 80% of houses have *some* insulation of hot water tanks.

Cavity fill insulation has been applied to over 10% of suitable properties, but solid wall insulation (which is more expensive and so of lesser cost-effectiveness) has made a very small impact.

Double glazing (including secondary glazing, dual glazing, and replacement sealed units) is now fitted to some extent in 20% of houses. This market penetration shows that measures of uncertain cost-effectiveness in purely energy terms can be perceived by householders as valuable improvements to their living conditions.

Calculations of cost-effectiveness may thus need to include some 'non-energy' factors, in order to equate them to practical experience. Furthermore the arguments over appropriate economic investment criteria are still unresolved and it has been suggested that any measure is cost-effective if its annual amortised cost over the mortgage period of the structure is less than the annual value of energy saved.

Proposed programme and energy saving targets

Although the different market sectors have different needs and priorities for energy conservation, it is convenient to list the required demonstrations in terms of the technologies to be employed. The acquisition of several demonstrations may be

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expedited by liaison with the manufacturers of specific technologies. The types of measure to be included in the programme are set out below.

Ventilation control, draughtstripping etc

- This includes control of ventilation and air infiltration, and heat recovery from exhaust air. This group includes items of very low technology (which have low costs, small savings individually, but very good cost effectiveness and large potential national benefits) and items of obviously novel high technology. The pattern of demonstration has to be very different for the two groups, both in terms of monitoring and of publicity and dissemination.

  The strategy envisages 9 demonstrations, covering several technologies and building types (Table 25.1). Attention will be concentrated initially upon the control of air infiltration, leading next to simple heat recovery from ventilation systems, and then to fully controlled mechanical ventilation in highly sealed buildings. It is thought that these demonstrations could cost up to £500,000, but could lead to energy savings of 1.5 Mtce/year (this is approximately ⅓ of the potential realistic savings to the year 2000).

Insulation of external walls

- *Cavity fill insulation.* This item has only low priority, as the technology is widely established even though problems still occur with particular systems. A study of cavity fill forms a major part of the Department of the Environment's research programme because of the implications for Building Regulations. The scope for demonstration is limited to areas of high exposure, or difficult accessibility, where decision makers need to be assured of the cost-effectiveness. Two demonstrations are proposed, total cost approximately £150,000 leading to savings of perhaps 50,000 tce/year in highly defined situations.

- *Solid wall insulation,* including both internal and external treatments. 40% of existing houses have solid walls and only a very small number of them (200,000) are yet insulated. A number of competing systems are now available and, although their long term durability can only be assessed from short term extrapolations, it is felt that demonstrations of energy cost-effectiveness are now appropriate. External treatments are expensive, particularly if applied to individual houses rather than to whole estates at a time. Decision makers need to be assured that systems are sound and do not lead to other structural problems, as well as being cost-effective. Internal treatments are simpler in some respects, but cause more disturbance in installation, reduce the area of the rooms and may lead to problems of interstitial condensation, or 'cold bridging'. Demonstrations should show that those disadvantages are outweighed by the real energy savings which result from the reduced transmission losses and the quicker response time.

  The range of demonstrations shown in Table 25.1 allows for projects in different building types and different degrees of exposure. Thirteen projects will cost £1.25M but could influence decisions leading to the saving of 2.5 Mtce/year. This is a five-fold increase on progress to date, but is still less than half of the feasible target.

Insulation of other parts of the fabric

- Extra underfloor insulation can be cost effective in new buildings, but is not yet worthwhile as a retrofit activity. Demonstrations are needed to prove the value of this technique in new buildings, and there may later be an appropriate installation method for suspended floored existing buildings. Three demonstrations are proposed, and savings could amount to 100,000 tce/year.

- *Improved loft insulation* products may also lead to greater percentage take up — particularly in the DIY sector — and demonstrations should concentrate upon the reduction in installation hazards. Only one demonstration is proposed, although potential savings exceed 100,000 tce/year.

- A major problem concerns the *insulation of flat roofed houses.* These include local authority properties, and many architecturally praised private sector designs of the 1950s. There is an urgent need for a demonstration of a convincing solution for these householders. An initial programme of three demonstrations could lead to savings of 250,000 tce annually.

- *Double glazing* products will sell without the need for demonstration, but careful monitoring of selected projects would provide useful information for Government and industry in making cost-effective improvements. Two demonstrations could influence decision makers and lead to savings of perhaps 100,000 tce/year.

In all, nine demonstrations are envisaged in this general area of insulation technology. The costs would be low compared with some buildings demonstrations (perhaps £600,000) but the savings could amount to 600,000 tce/year.

Space heating systems

- *Fuel substitution and boiler replacement.* Many public sector flats built in the 1950s and 1960s were fitted with electric (underfloor or ceiling) heating. The high cost of full price electricity has led to many complaints from tenants, and to severe condensation in the (often poorly insulated) flats. Housing authorities are seeking alternative heating systems, but there are particular difficulties for those outside the Gas Supply Areas. A survey is currently under way to identify the most cost-effective solutions, after which a series of demonstrations can be mounted. The maximum saving could be 4 Mtce/year but a more modest target of perhaps 1 Mtce/year is hoped for, from perhaps 4 demonstrations.

- *Smaller systems.* Space heating requirements become proportionately lessened in smaller or better-insulated houses, and there is a need for heating systems (of low capital cost) which can work efficiently and in an easily controlled manner at lower outputs. Two demonstrations of newer systems are envisaged, with a potential benefit of 150,000 tce/year.

- *Condensing boilers,* pulsed combustion boilers and, later, heat pumps will soon have completed Research and Development and field trial stages, and will be ready for the demonstration of commercially available products. The technological potential is very great (10 Mtce/year) but a realistic replication target of 1 Mtce/year is possible following a sound programme of demonstrations.

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The original strategy called for only six demonstrations in these three areas, but market forces and appliance life times are such that a wider range of projects could be helpful. It is now suggested that about 10 schemes are supported, at a total cost of £600,000 (the high capital grants in this area will be offset by simpler monitoring requirements). But the savings could reach 2 Mtce/year.

Control systems

- Control devices should not be considered in isolation from the heating systems in which they operate. Nonetheless controls are often sold separately in this fast developing area. Products suitable (in price and scale) for the domestic market are now being developed from the earlier commercial scale devices. There is a wide range of options, from 'feedback devices' through to highly 'intelligent' systems with remote metering facilities. In many cases the claimed energy savings will only be manifest if energy consumption was 'excessive' previously but there could be a need for approximately 10 demonstrations of different approaches to the control of space and water heating, taking account of the lifestyle of different household types.

  Ten projects would cost a minimum of £400,000 although a more sociological type of monitoring would increase this. Few specific projects have been listed, as a review of plans for this area is still in progress within the Building Research Energy Conservation Support Unit (BRECSU).

Water heating systems

- This technology encompasses heating appliances, heat exchangers, control systems and insulation. There is scope for many demonstrations, as the host's capital costs are relatively low, the decision making cycle is shorter than for space heating and building fabric, and the technologies can be cost-effective at an earlier date. Limiting the number of projects to 9 implies a total cost of perhaps £500,000 but could give annual national savings of 1.5 Mtce/year.

Heat metering and communal heating

- *Heat metering* is a contentious subject. Tenants and landlords disagree about the principles of charging and the accuracy of metering, but it is often claimed that 5–15% less fuel would be consumed if tenants were more directly charged for the energy they use. Nonetheless, a heat meter does not of itself save any energy (in this respect it is similar to a feedback device or an energy audit) and there has been some suggestion that heat meters are inappropriate subjects for demonstration. BRESCU takes a different view, and has a number of projects and prospects in its portfolio. Acceptable forms of heat metering will be essential if combined heat and power (CHP) or district heating (DH) schemes are to be widely installed. The considerable interest in this subject shown by the Department of Energy gives added importance to this area of demonstration.
- *Communal heating systems* can include small scale CHP plants as well as large district heating schemes. They take a low priority in BRECSU's current programme, but could be raised if resources become available.

The total cost of projects in this area is estimated as £510,000, and savings could amount to 400,000 tce/year.

Packages of measures

- Major rehabilitation schemes, like new building projects, rarely include just one novel energy saving device. There is a possible synergism between measures, and with the existing fabric. In new work the designer can take account of siting and orientation to use devices which would not be cost effective in an existing building. Demonstrations must reflect reality and must provide the information which other designers not only need but also want and can use. This will often require the demonstration of a design concept, or of a group of related measures, which can be replicated as essentially the same grouping in later buildings. Monitoring of such packages should concentrate upon the benefits of the overall group of measures, without attempting to disaggregate the contributions of individual devices. The three types of building work listed in the table (ie conversions, rehabilitation, and new works) call for at least 20 projects. They will cost approximately £1.6 million including monitoring, although later schemes may be capable of cheaper monitoring when more accurate predictive programmes are available. Total savings could reach 3 Mtce/year, if well replicated.

Other projects

- This area includes design procedures, home audits, advice schemes, conservation areas, competitions — ie measures which are primarily 'software' rather than 'hardware'. Some topics will be pursued more strongly by BRECSU (eg design procedures and advice schemes) but others may arise from unsolicited proposals. It is not realistic to assign costs or targets to this wide group, and so each proposal will be taken as a 'one-off'.

Replication

BRECSU has generally attributed quite modest replication targets to particular projects, even though the maximum national potential is often very much greater. This reflects the difficulties — and in many cases the inappropriateness — of attempting to persuade decision makers from other parts of the country to adopt a technology which has been proven elsewhere. There is often a need for several demonstrations of the same measure, in different regions and different circumstances, in order to overcome this. The modest targets also acknowledge the difficulty of ensuring that all possible replication is measured and attributed to the Demonstration Scheme.

In order to assure wide-spread replication a very much greater publicity and promotional effort is needed. The programme set out above could lead to larger national benefits if actively and aggressively promoted. For this reason the total target savings for each technological sub-sector have been presented (a) as the arithmetic sum of the modest savings attributable to each local project, and (b) as a larger figure allowing for synergism between projects and wider publicity of all types. (It should be realised that such publicity could not proceed *without* the demonstrations. The projects provide the data for the publicity effort.)

A further barrier to replication is the shortage of available capital, particularly for local authorities and other bodies that incur energy saving expenditure without gaining the direct

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benefits of their investments. In spite of the accepted importance of energy conservation, short term priorities may lead to a postponement of conservation activity.

Some of BRECSU's early projects are now almost complete, but none has yet been the subject of a major promotional campaign. It is hoped that when information has been distributed to replicators BRECSU can be kept informed of the extent of take up by commissioning occasional market surveys as well as by receiving data from product manufacturers and specifiers.

The projects outlined above, and listed in the tables, form a complete portfolio of almost 100 projects. The cost of the ED Scheme is estimated as £6.5 million, but this relates only to the grants to hosts and monitoring agents, and does not include the substantial promotional effort which will be needed. The potential benefits from this programme are estimated as a minimum of 4.5 million tonnes of coal equivalent annually, rising to 14 million tonnes if the wider take-up is assumed.

Current status of the programme

BRECSU is currently managing nine active projects, including two in the early stages of promotion. The measures being demonstrated include ventilation control devices, insulation systems, heating plant, and packages of measures in both new buildings and rehabilitation schemes. The projects are listed in Table 25.2: replication targets of at least 218,000 tce/year are expected from projects costing £750,000. Several other prospects are in advanced states of preparation, or discussion with proposers. It is envisaged that they will be contracted and active in 1984, and will lead to further savings of 200,000 tce/year.

Future plans

The development of proposals has been much slower than expected, partly due to a lack of understanding of the Scheme by potential hosts, and partly due to the small incentives for them to participate. Not unreasonably, hard pressed building owners have not felt inclined to prepare detailed proposals simply to gain a grant on a small part of their total costs. Instead BRECSU staff have needed to assist the proposers far more than was first envisaged. This high level of involvement with early (unsolicited) proposals has hindered BRECSU from taking more positive action and seeking specific proposals. It is hoped that some small start can now be made in this direction.

If the programme has to be constrained for any reason, it will be necessary to concentrate upon priority areas. The areas in which most energy savings can be made, and which should therefore receive priority attention, include Ventilation control, Solid wall insulation, Design packages, and (later) Fuel substitution. The topic of improved controls, which is also an important one, could become the subject of collaborative R&D with manufacturers, leading to commercial promotion, rather than the subject of demonstration. In all other areas, a smaller number of projects would be undertaken, but they would be further delayed because of the need to carry out a far more critical assessment of which (few) projects should be supported.

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Table 25.1 Domestic buildings: Proposed programme

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
VENTILATION CONTROL	*	1	Trickle ventilators at Abertridwr	15	25	Sept 1983
	+	2	Heat recovery system in Scottish Local Authority housing	50	150	Mar 1986
	+	3	Heat recovery system in North Eastern Housing Association housing			
	+	4	Simple stack ventilation in Local Authority property	10	30	Mar 1986
	o	5	Sealing construction gaps in new owner-occupied housing			
	o	6	Sealing existing housing during rehabilitation			
	o	7	Mechanical ventilation in Local Authority flats	340	270	Apr 1986
	o	8	Mechanical ventilation in new owner-occupied housing			
	o	9	Draughtproofing materials — suite of projects			
			(a)	415	475	
			(b)	1500		
INSULATION OF EXTERNAL WALLS	*	10	External insulation of Woolaway houses — Tewkesbury Borough Council	10	125	Sept 1983
	*	11	External insulation of Local Authority properties at Harrow	80	100	Dec 1983
	o	12	Cavity fill in high rise properties and other 'difficult' situations or construction types	50	150	Mar 1986
	o	13				
	+	14	External insulation of Scottish flats			
	+	15	External insulation of multi-storey blocks			
	o	16	External insulation for exposed situations			
	o	17	External insulation cost effective for single house	300	600	June 1986
	o	18	Cost effectiveness of extreme thickness			
	o	19	Simple system for single storey dwellings			
	o	20	Use in new solid walled housing in Scotland			
	+	21	Internal insulation of housing association properties in Liverpool	14	117	Sept 1986
	o	22	Range of projects using different drylining techniques to overcome problems of detailing and moisture barrier in specific house types	236	283	Sept 1986
	o	23				
	o	24	Drylining techniques specific for DIY markets			
			(a)	690	1375	
			(b)	3000		
INSULATION OF FABRIC OTHER THAN WALLS	o	25	Improved products for insulating windows including solar films and insulating shutters	100	100	June 1986
	+	26				
	+	27	Improved products for loft insulation	100	50	Sept 1986
	o	28	Increased underfloor insulation in new housing			
	o	29	Retrofitting underfloor insulation (suspended floor)	100	200	Sept 1986
	o	30	Insulation between party floors			
	+	31	Insulation of flat roofed properties			
	o	32	Insulation of flat roofed older properties	250	180	Mar 1986
	o	33	Top floor flats and lift rooms			
			(a)	550	530	
			(b)	600		

(a) identifiable replication target
(b) attributable replicaton target depending on wider promotions

KEY * Existing project
+ Prospective project
o Required project

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Table 25.1 Domestic buildings: Proposed programme (continued)

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
CHANGES TO FUEL OR HEATING SYSTEMS	o	34	Replacement of electric underfloor systems or ceiling heating systems in			
	o	35	Scottish local authority flats	250	180	Mar 1986
	o	36	Similar project in less demanding location			
	o	37	Low cost systems for smaller premises	150	120	Mar 1986
	o	38				
	+	39	Packages to improve efficiency of boilers in situ	15	40	Dec 1985
	+	40	Installation of condensing boilers, both as			
	+	41	retrofit and new systems in range of properties	220	180	Dec 1985
	o	42	and boiler sizes (3 or 4 separate projects)			
	o	43				
	o	44	Replacement of oil fired boilers by heat pumps	60	80	Mar 1987
			(a)	695	600	
			(b)	2000		
CONTROL SYSTEMS	+	45	Energy management in sheltered housing			
	+	46	Energy management in grouped accommodation			
	o	47	Intelligent systems for family housing	400	400	Sept 1986
	o	48	Individual room control by space and time			
	o	49	Retrofit boiler anticycling devices			
	o	50	Other proposals not yet defined			
			(a)	400	400	
			(b)	1500		
WATER HEATING SYSTEMS	*	51	Separation of space and water heating in Anchor Housing Association flats	25	21	Apr 1985
	+	52	Improved systems for student accommodation	20	40	June 1985
	o	53	Individual systems in communal blocks	30	80	June 1986
	o	54	Combined warm air hot water storage system	50	40	Sept 1986
	o	55	Improved insulation on cylinders and pipes	200	180	June 1986
	+	56	More efficient heat exchangers			
	o	57	Other projects depend on progress with boilers			
	o	58	and controls	100	120	Dec 1987
	o	59				
			(a)	425	481	
			(b)	1500		
HEAT METERS, COMMUNAL HEATING AND MINI CHP	*	60	BICEPS system at Islington	24	80	Apr 1985
	+	61	Integrating systems on large district housing schemes in North East England	40	70	June 1986
	o	62	Prepaying metering	50	80	Mar 1986
	o	63	New district heating with full metering	50	100	June 1986
	o	64	Simplified system for tower blocks	30	80	Mar 1986
	o	65	Small scale combined heat and power (CHP) on new development or for university	80	27	Mar 1986
	o	66	accommodation			
	+	67	British small-scale CHP system for use in Local Authority tower block	20	73	May 1986
			(a)	294	510	
			(b)	400		

(a) identifiable replication target
(b) attributable replication target depending on wider promotions

KEY

* Existing project
† Prospective project
o Required project

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Table 25.1 Domestic buildings: Proposed programme (continued)

Sector	Key		Project	Target savings '000 tce/y	Cost to ED £'000	Promotion start date
NEW BUILDING DESIGN	*	68	Low energy housing at Manchester	10	70	Apr 1984
	*	69	Single person accommodation at Milton Keynes — Society of Co-operative Dwellings	35	100	May 1985
	+	70	Starter homes	20	80	June 1986
	+	71	Low cost private sector terraced housing	10	50	Dec 1986
	o	72	Family dwellings for housing association in North East	70	200	June 1986
	o	73	Local Authority housing for disadvantaged			
	+	74	Energy efficient housing for the disabled and elderly			
	o	75	Local Authority flats and maisonettes			
	o	76	Private sector family housing	40	100	Sept 1986
	o	77				
			(a)	185	600	
			(b)	2000		
REHABILITATION AND CONVERSION	*	78	Urban renewal in Birmingham	50	130	Apr 1985
	+	79	Feasibility study of energy efficient rehabilitation of 1960s flats	60	80	Jan 1986
	o	80	Interwar terraces in Midlands	20	70	June 1986
	o	81	Communally occupied properties in city centres	25	90	
	+	82	Feasibility study of energy efficient rehabilitation of interwar L.C.C. blocks	40	100	
	o	83	Schemes similar to Birmingham, repeated in other communities	50	200	
	o	84				
	*	85	Conversion of flats and new house building at Sydenham — South London Consortium	12	110	Jan 1984
	o	86	Housing Association rehabilitation in West Country	70	200	Dec 1986
	o	87	Private sector conversions			
	o	88	Small conversions for single people			
			(a)	327	980	
			(b)	1000		
OTHER PROJECTS	+	89	Comparison of computer packages	500	500	Varies
	+	90	Energy conservation areas			
	+	91	Neighbourhood advisers			
	o	92	Commercial audits			
	+	93	Advice packages for private sector			
			(a)	500	500	
			TOTAL (a)	4481	6451	

(a) identifiable replication target
(b) attributable replication target depending on wider promotions

KEY * Existing project
+ Prospective project
o Required project

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Table 25.2 Domestic Buildings: Replication and energy saving targets for existing projects

	Project	Project profile number	No of organisations and dwellings in primary target market	Energy savings (A) and required number of replications (B): Dec 85 A '000 tce/y	Dec 85 B No '000 dwellings	June 88 A '000 tce/y	June 88 B No '000 dwellings	Long term A '000 tce/y	Long term B No '000 dwellings	Potential equipment suppliers or other consultants
	VENTILATION CONTROL									
1	Trickle ventilators in well-sealed, highly insulated houses (for UK Housing Trust, Abertridwr)	109	All builders of new houses (50 major companies 200,000 houses per year incl. public sector) and owners of existing well sealed houses	3	60	5	100	15	300	Trickle ventilators supplied by Titon Hardware Ltd, Greenwood Air Vac Ltd, E Hinchliffe & Sons Ltd, Critall Windows, Gorud Code Sales & others
	INSULATION OF EXTERNAL WALLS									
10	External insulation of Woolaway houses (for Tewkesbury Borough Council)	88	Local authorities & private owners of solid walled houses — particularly concrete built systems in West Country (20,000)	1	1	3	3	10	10	Wide range of companies & agents providing composite systems — not all companies are members of EWIA
11	External insulation in conjunction with partial central heating (for London Borough of Harrow)	110	As above but particularly to brick built houses in Greater London (100,000)	2	2	10	10	80	80	
	WATER HEATING SYSTEMS									
51	Separation of space & water heating systems in elderly persons' flats (for Anchor Housing Association)	121	All local authorities (~500) & Housing Associations catering for the elderly (many thousand dwellings in blocks of flats of this type)	—	—	5	10 (ie 300 blocks)	25	30 (ie 1,000 blocks)	Andrews Industrial Equipment, Gledhill, Ascot & other manufacturers of gas water circulators & all manufacturers of gas space heating boilers
	HEAT METERS									
60	Installation of BICEPS system in Local Authority flats (for London Borough of Islington)	156	All estates heated for DH or CHP schemes	—	—	4	10 (ie 100 blocks)	24	65 (ie 650 blocks)	BICEPS Ltd as suppliers of this specific device. Principles of metering applicable to other manufacturers (eg Clorius)
	NEW BUILDING DESIGN									
68	Low energy housing at Manchester (for Manchester City Council)	89	All local authorities, housebuilding companies, housing associations etc — particularly LAs in North West	1	1	3	3	10	10	Replication from designers, architects & contractors, rather than specific manufacturers
69	Housing for single young people (for Society for Cooperative Dwellings)	170	All house builders & clients, but primarily addressed to provision for single persons	—	—	3	6	35	60	Replication through designers etc, rather than suppliers

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Table 25.2 Domestic buildings: Replication and energy saving targets for existing projects (continued)

	Project	Project profile number	No of organisations and dwellings in primary target market	Energy savings (A) and required number of replications (B): Dec 85 A '000 tce/y	Dec 85 B No '000 dwellings	June 88 A '000 tce/y	June 88 B No '000 dwellings	Long term A '000 tce/y	Long term B No '000 dwellings	Potential equipment suppliers or other consultants
	REHABILITATION AND CONVERSION									
78	Urban renewal (for group of private house-owners in Birmingham)	147	Landlords of inner city properties & local authorities	—	—	10	10	50	50	As above. Benefit due to management and supervision rather than specific suppliers
85	Conversion of flats, plus new house building at Sydenham (for South London Consortium)	30	Owners of large houses for conversion. Local authorities, house building companies	—	—	2	1	12	8	As above
			TOTAL	7	64	45	153	261	613	

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